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ELECTRIC ILLUMINATION.

The paper read by Prof. Anthony at the Philadelphia meeting of the American Institute of Electrical Engineers showed that comparisons between different sources of illumination should not be made on the basis of the candle power alone, and it was demonstrated that for efficient lighting a great deal of what we may call the watt economy of large units like arcs is lost. In the Digest will be found an abstract from a French author that extends the calculations of Prof. Anthony, and gives a simple graphical method for determining the height at which a source of illumination should be placed in order to obtain the most efficient lighting. It would seem that the reflector above alternating arcs might be so shaped as to obtain more nearly the distribution of light most desirable, and that with continuous current arcs a more efficient distribution might be attained by the use of an upper carbon different in size and quality from the lower one. The subject of illumination has not yet received the attention it deserves and probably will not until a standard of illumination has been adopted. Candle power is not the only factor that enters, and if this were more widely recognized we would not see so many arcs used in small towns and villages, where the incandescent lamp for street lighting would not only be more appropriate and efficient, but also in most cases less expensive for the same average illumination.

THE AMERICAN ELECTRO-THERAPEUTIC ASSOCIATION.

We print elsewhere the preliminary programme of the fourth annual meeting of the American Electro-Therapeutic Association to be held in New York City the latter part of next month, which, it will be seen, is a most extensive one. Many of the names of those who will read papers are familiar to all electricians, for besides Drs. Goelet, Morton, Herdman, Apostoli and others whose reputations have extended beyond medical circles, we find Messrs. Kennelly, Houston, W. J. Jenks and Profs. J. W. Langley, J. O. Reed and A. E. Dolbear, representing the more purely electrical profession. That electricity occupies such a prominent place in the medical profession as implied by the programme of this society, of which there are several similar ones in this country, is somewhat surprising, and is another indication of the manifold nature of the new agent. One of the hoped for results from these bodies is a recasting of electro-medical nomenclature to bring it more into harmony with modern electrical language. The queer jargon found in some works on medical electricity may at one time have had its use, but now that we have an authoritative system of electrical names and notation, based upon logical and scientific principles, it would seem that medical nomenclature could be brought into closer accord with it. The different properties of electrical currents can be clearly expressed without resorting to names based upon their origin, and writing of faradic, voltaic, galvanic and franklinic currents as if they were distinct varieties of electricity.

PRECISION OF MEASUREMENTS.

It is often amusing to see the manner in which figures are carried out to a large number of decimal places, when the accuracy of the measurement of the quantities to which they refer is perhaps limited to the place of units. Many persons have an idea that greater accuracy results if a number is thus carried out to several places of decimals or if logarithms are used, and the writer once heard a man, who enjoys a national reputation as a mechanical expert, remark, when it was pointed out that certain measurements were probably not correct

within a unit, that he would use seven-place logarithms to calculate them with, and thus obtain very accurate results. A good rule to follow is not to carry out averages and other calculations more than one point beyond the limit of the accuracy of measurement, the extra figure being to take up fractions. To do otherwise merely adds figures that mean nothing and which are likely to give the impression that the writer is either seeking credit for an accuracy which is not deserved, or that he does not know that the limit of accuracy of measurements can not be extended by such additions. In computing the average readings of voltmeters and ammeters, for instance, we frequently find the figures carried out to the thousandths place when it is very doubtful if the unit place is right within a volt or ampere. There is no necessity for this show of accuracy, even if it is thought within the limits of probability, for in practically applying such numbers, all figures must be lopped off beyond the range of the scale to which they apply. In ordinary linear measurements, for example, one-hundredths of an inch is the usual limit, yet the expert above referred to on one occasion instructed a workman to lay off a dimension in which the decimal part of an inch was expressed to thirteen places, though the quantity had never been determined closer than the third place of decimals even in the physical laboratory. One of the reasons why practical men look askance at much technical writing is because their training makes such absurdities very apparent and therefore naturally creates a prejudice in their mind against the practical value of everything the author says.

POLYPHASED MOTORS.

We publish in this issue Dr. Bell's Institute paper on polyphased motors, which will repay careful reading, for it is probably the most practical contribution on the subject yet made. Two of the notable advantages of induction motors are strongly brought out—the absence of commutators and freedom from burn-outs—which imply that no skilled attendance whatever is required in their use. Another advantage is that such motors can be placed equally well in any position—upside down or on their side—and in any out-of-the-way place, as the only attendance required is attention to bearing oil cups. It is shown that such machines may stand an overload of from 30 to 60 per cent., and that if loaded beyond a point that might involve damage, the motor stops, when a fuse will cut off the current. The close regulation of induction motors is one of their good points, and Dr. Bell states that in ordinary good practice the speed variation, will not be greater than 5 or 6 per cent. from no load to full load, while they have been designed with no difficulty to reduce this variation to 2.2 per cent. or less. As to great speed variation it is stated that this can be accomplished through the same range, and with as much facility, as with the series continuous current motor controlled by a rheostat, and that the falling off in efficiency is no greater with the former than with the latter. Comparison also with continuous current shunt motors leads to the general conclusion that the polyphased motor is perfectly capable of a complete control of speed on the same terms generally obtained with continuous current motors. It would be interesting to know if this would be commercially the case with polyphased motors applied to mining purposes, where the speed must be subject to wide variations in pumping, hoisting, etc. About two years ago a contrary conclusion, after wide investigation, was arrived at, with the result that their use was not recommended in a case where otherwise several thousand horse power would have been employed. It should be added that in this particular case, continuous current motors were not considered sattsfactory on account of the care and low voltage required, and the necessity of their being installed in only favorable places, and that these properties of the polyphased motor led to the investigation which was made with a view to displacing the others, and to largely extending the electrical plant. Another point of interest in the paper is, that through the working range of a well designed induction motor the false current is very small, and is only about 30 per cent. at friction load. This shows that the claim of requiring larger generators on account of false currents and of the line being loaded up by them has little foundation in fact. Even if the false current was much larger than here shown at light loads, it would not require a larger size of line conductor, as sometimes claimed, for the full load current is always almost in phase with the E. M. F. and greater than the volt-ampere current at any other load.

COST OF PRODUCING ELECTRICAL ENERGY.

The paper read by Mr. B. J. Arnold at the recent convention of the North Western Electrical Association, and reprinted in The Electrical World of last week is a valuable contribution to a subject that has not received the attention in the past that its importance calls for. In the present issue we print the first portion of an article from an English correspondent which adds some further valuable data. The cost of electrical energy depends so largely upon the load factor that without assuming a value for this, any result quoted is likely to be very misleading. To increase this factor is now the greatest problem before central station managers, and the suggestion of Mr. Arnold to add an ice plant is an excellent one. It is also unquestionable that notable economy will result from the addition of a storage battery, both from a reduction in first cost of a plant and from the machinery being continuously operated at its point of maximum efficiency. To these should be added a saving in fuel from less waste by radiation, and less waste in furnaces from banked fires and admission of surplus air to light fires, and also in the cost of labor per ton of fuel burned. While in some cases a considerable distributed motor load may be added, in the great majority of stations thus far not much assistance has been obtained in this way, and it will be good policy for the station manager to attempt to open up other avenues of relief. In most of the data given for the cost of electrical energy, fixed charges are omitted, notwithstanding that it is one of the largest factors. In our issue of June 9 we showed that the investment per kilowatt in twelve dividend paying stations in Massachusetts averaged $573, and in many exceeded $600 per kw., though it is probable that this exceeds what similar plants could be laid down for to-day. We will assume that the above figures can be reduced to $500 per kilowatt, of which $400 represent that part of the plant subject to depreciation, which will be assumed at 5 per cent. per annum. The calculations upon which the following table is based rest almost entirely upon assumptions, but it may, however, serve as an illustration of the effect of various factors, and by filling in the actual figures for a given case, will perhaps furnish indications of some direct value. The different quantities in the first column are based to some extent upon the figures of Mr. Arnold and the reports of the English Board of Trade, and the other columns show how they are affected by the load factor. The capital charges are on a basis of 6 per cent., and the depreciation and current repairs are assumed somewhat higher for larger loads, and the cost of fuel lower.

Table Showing Effect of Load Factor.

Load Factor	.2	.4	.6	.8
Capital Charges	1.70	.85	.57	.42
Depreciation	1.20	.66	.44	.33
Management and Taxes	1.50	.75	.50	.40
Current Repairs, etc	1.00	.55	.40	.30
Fuel	1.50	1.40	1.30	1.20
Labor	1.50	1.20	1 00	.90
Petty Stores	.20	.15	.10	.08
Cost per kilowatt-hour, cents	8.60	5 56	4.31	3.63

As the total for a load factor of .2 is much below what is now attained in this country, the table does not represent present practice, but the different factors are believed to represent what may easily be realized.

Behind the Times.

In a recent meeting of the London Technical Education Board, Mr. Senior, a delegate representing the electrical trades, stated that the electrical industry was as yet in its infancy, and was in a very crushed condition.

Electric Lighting in Great Britain.

BY E. RAY STEVENS.

It is a recognized fact in Great Britain that America is much in advance of the United Kingdom in the perfection and in the use of electricity as a means of public lighting, and especially as a motive power. An inspection of the plants here shows that a surprisingly large number of them are fitted with American machinery, despite the fact that much machinery for this purpose is now being manufactured in England.

In the use of electricity as a motive power England has been very backward. All told there are not more than a dozen electrical street railway lines in the United Kingdom, and some of these are experiment lines only, as is the case with a short line recently built by the Thomson-Houston Company at Leeds. That city has just purchased the lines of the private company that had been operating them, and will replace the engines now used upon the lines with either cable or electricity. Liverpool has a very successful elevated railway operated by electricity. In Birmingham it is being used on a portion of the city tram lines. Blackpool has an underground conduit system, and besides these cities there are not to exceed a half dozen others where electricity is used as a motive power on the street railway lines.

One reason for this condition is found in the great opposition to its adoption on the part of the National Telephone Company, which was so completely in possession of the field that it was usually able to defeat all attempts to use electricity as a motive power, because of the fact that its use interfered with the workings of the telephone lines. But this opposition has now been made much less effective. There is a general feeling among tram managers that some other power should be adopted in place of the horses and the engines now largely employed. Electricity and cable are the favorites. Electrical traction will undoubtedly make great advances in Great Britain during the next decade.

The electric lighting industry, like that of supplying gas and local transportation, is regulated by an act of Parliament, and is placed under the immediate supervision of the Board of Trade, which has very wide powers in controlling the establishment and the operation of plants for supplying electric light. This law, passed in 1882, contained a clause giving cities the power to purchase their plants at the expiration of twenty-one years, as well as at the end of every period of seven years thereafter upon paying the present worth of the plant as fixed by arbitration. It was especially provided that this value should be fixed without "any addition in respect to compulsory purchase, or of good will, or of any profits which may or might have been or be made from the undertaking, or of any similar consideration."

The speed of electric lighting was undoubtedly hampered by the provisions of the act, as it was found difficult to secure capital upon favorable terms for the establishment and operation of the business, which was at that time considered in England a rather uncertain investment, even under favorable conditions. But the act was amended in 1888, extending the period at which the city had the option to purchase to forty-two years, and to every ten years thereafter. Since that time the extension of electric lighting has been more rapid, partly due, no doubt, to the amendment.

The Board of Trade has the power to grant provisional orders, which must be sanctioned by Parliament. Licenses, which are good for seven years, may also be given, but, as a matter of fact, this is rarely done now. The act grants the usual powers to the company, and at the same time reserves to the Board of Trade a large control over the affairs of the company, subject, of course, to general provisions as to the manner in which the plant is to be established and operated.

When a company applies for a provisional order, a formal notice of the action must be given to all those who are at that time engaged in supplying electricity in that district. The application must be accompanied by detailed information as to the kind of plant to be established and the district to be supplied. It must also show that the consent of the local authority has been gained, and the company must demonstrate to the satisfaction of the Board that it is able to carry out the proposed work, and if the order is granted it must make a deposit as security for the faithful execution of the plans proposed. Its system must be sanctioned by the Board, and, if overhead construction is to be used, the express sanction of the municipality must be obtained as well. There is, however, little opposition to the overhead system outside the larger cities.

The regulations provide, with considerable minuteness, the manner in which the lines shall be constructed and maintained. Especial care is taken in regard to the support and insulation of the wires, so as to prevent, if possible, all injury to the public. When once established the plant is obliged to supply all those who wish the service that are within its district. The Board fixes the methods that may be employed in charging for the service, and also the maximum price that may be collected for it.

The companies are required to prepare and have printed annual statements that will show the receipts and expenditures of their business. These they must keep for sale to all who care to buy them at a price not to exceed one shilling. In order to insure their correctness, auditors are appointed, who, each year, examine the books and accounts that have been prepared. The expense of this examination is in each case borne by the company. Provision is also made for the appointment of inspectors, whose business it is to periodically examine the plant of the company and to make special examination of meters or portions of the line when complaint is made. Electricity is to be supplied to all customers by meter, but this, like some of the other general regulations, may be varied by mutual agreement.

LONDON, ENGLAND.

(To be continued.)

American Electro-Therapeutic Association.

The following is the preliminary programme of the American Electro-Therapeutic Association, which will hold its fourth annual meeting at the New York Academy of Medicine, New York, Sept. 25, 26 and 27.

President's address, by Dr. W. J. Herdman, Ann Arbor, Mich.

Report of committees on scientific questions:

On Standard Coils, by Dr. Wm. Jas. Morton; on Standard Meters, by Dr. Margaret A. Cleaves; on Standard Electrostatic or Influence Machines, by Dr. Wm. Jas. Morton; on Constant Current Generators and Controllers, by Dr. W. J. Herdman; on Standard Electrodes, by Dr. A. Lapthorn Smith; on Stand and Electrode for Static Electricity, by Dr. Lucy Hall-Brown; on Electric Light as a Therapeutic and Diagnostic Agent, by Dr. Margaret A. Cleaves.

THE CONSTANT CURRENT.

Current Distribution, by Mr. W. J. Jenks; Physiological Effects, by Prof. A. E. Dolbear; Therapeutic Uses, General, by Dr. A. D. Rockwell; The Galvanic Current in Catarrhal Affections of the Uterus, by Dr. G. Betton Massey; Suites e'Loignees du Traitment Electrique Conservateur Gynæcologie, Grossesses Consecutives, by Dr. Georges Apostoli, Paris; Metallic Electrolysis, by M. le Docteur Georges Gautier, Paris; Dr. Wm. Jas. Morton, Dr. Margaret A. Cleaves, and Dr. A. H. Goelet, New York; Treatment of Urethral Stricture, report to date, by Dr. Robt. Newman; Diseases of the Eye, Electro-Therapeutics of, by Dr. L. A. W. Alleman; Notes on Goitre and Improvements in Apparatus for Treatment of Same, by Dr. Chas. H. Dickson; Diseases of the Throat, by Dr. D. S. Campbell; The Action of Electricity on the Sympathetic, by Dr. A. D. Rockwell; Diseases of the Nervous System, Treatment of Neuritis by the Galvanic and Faradic Currents, by Dr. Landon Carter Gray; Electric Sanitation, by Prof. John W. Langley; Physics of the Electric Light in Relation to Organized Matter, by Prof. John O. Reed; Hydro-Electric Methods, Physics and Appliances, by Mr. Newman Lawrence, London; Special Hydro-Electric Applications, by Dr. Margaret A. Cleaves; The Hydro-Electric Therapeutics of the Constant Current, by Dr. W. S. Hedley, Brighton, England.

INDUCTION CURRENTS.

Interrupted Currents, Physiological Effects, by Dr. W. J. Engelmann; Therapeutic Uses, General Faradization, by Dr. A. D. Rockwell; Gynæcological, by Dr. A. H. Goelet, Dr. H. E. Hayd and Dr. A. Lapthorn Smith.

SINUSOIDAL CURRENT.

Physics, by Mr. A. E. Kennelly; Physiological Effects, by Dr. W. J. Herdman and Dr. J. H. Kellogg; Therapeutic Uses, by Dr. Margaret A. Cleaves, Dr. Wm. Jas. Morton, Dr. J. H. Kellogg, Dr. Holford Walker and Dr. A. H. Goelet; Les Courants Alternatifs; Leur Transformation, Leur Mesure et Leurs Applications Therapeutics, by M. le Docteurs Gautier et Larat, Paris; on the Sinusoidal Current Method of Regulation, the E. M. F. and Resultant Current, by Dr. Lucy Hall-Brown, Brooklyn, N. Y.

STATIC AND STATIC INDUCED.

Physics, by Prof. Edwin J. Houston, Ph. D., Philadelphia; General Therapeutic Uses, by Dr. Wm. Jas. Morton; The Treatment of Chorea, by Dr. D. R. Brower; Static Induced, by Dr. Margaret A. Cleaves; High Frequency Currents derived from Static Machines as per Methode d'Arsonval, by Dr. J. H. Kellogg.

IN MEMORIAM.

Dr. Wm. F. Hutchinson, Providence, R. I.; Dr. John Chambers,

Indianapolis, Ind., by Dr. Robt. Newman, New York; Dr. Plymon S. Hayes, Chicago, by Dr. W. J. Herdman, Ann Arbor, Mich.

Design of Electromagnets for Specific Duty.—III.

BY E. R. CARICHOFF.

Fig. 1 shows the dimensions of a cast steel electromagnet, which, with an air gap of ⅛ in., pulls 1,200 lbs. when the exciting power is 4,800 amp. turns in either shunt or series coil. This gap is, for this particular case, the one which, multiplied by the pull of 1,200, gives a maximum, or 150 inch pounds. In case a movement over ½ in. instead of ⅛ in. is required, the plunger of the magnet may be attached to the short end of a 4 to 1 lever, at the long end of which

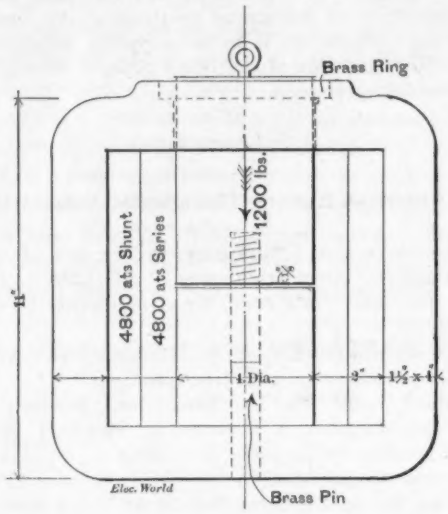


FIG. 1.

the travel will be ½ in., and the pull 300 lbs., or, as before, 150 inch pounds. If, however, the plungers are simply separated ½ in. the initial pull becomes about 132 lbs., which, multiplied by ½ in., gives 66 inch pounds or less than half what can be gotten by using the lever. All this supposes that the force to be overcome is fairly constant, or but slightly increasing. Of course, if the force to be overcome varies directly with the pull of the magnet, there is no need to bother about the air gap.

It is possible to get a direct pull of 300 lbs. at a distance of ½ in. by using the form of magnet in Fig. 2, which was suggested and adapted by Lieut. F. J. Sprague, of the Sprague Electric Elevator

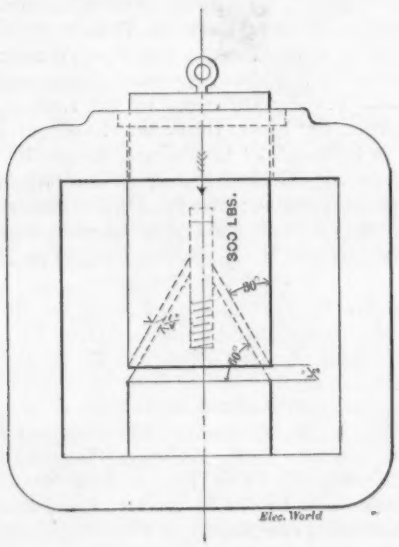


FIG. 2.

Company. The only change is in the air gap. With the angles there shown for the male and female cone plungers it is readily seen that the area of air gap is approximately doubled, and its length also doubled, while the reluctance is approximately the same as that of the arrangement in Fig. 1.

It is further readily seen that the travel of plunger is ½ in. instead of ⅛ in. as in Fig. 1.

As the reluctance of the circuit is approximately the same as in Fig. 1, the total number of magnetic lines is approximately the same. But as these lines are distributed over an air gap of double the area, and the force makes an angle of 60 with the direction of travel, the pull is only 300 lbs. at ½ in. This pull of 300 times ½ in. is, however, 120 inch pounds as before.

To change polar area and travel, keeping the reluctance approximately constant:

Suppose the approaching poles to be two cylinders with male and female conical extremities, as in Fig. 3.

If A is the cross-section and d the travel, and the proper length

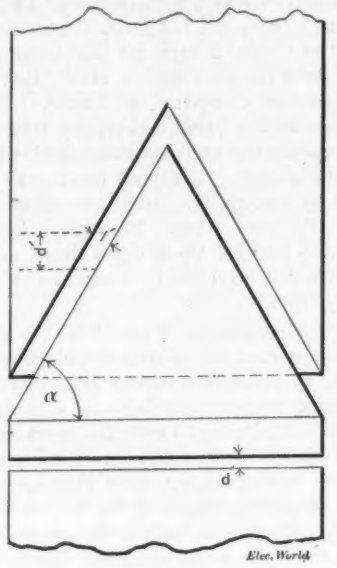


FIG. 3.

of air gap for a right section, A' is the polar area, l' the air gap length, and d' the travel when the angle at the base of the cone becomes a.

Condition of constant reluctance is $\frac{l'}{A'} = \frac{d}{A}$

But $A = A' \cos a$ and $l' = d' \cos a$;

Therefore, $\frac{d' \cos^2 a}{A'} = \frac{d}{A' \cos a}$

whence $\cos^2 a = \frac{d}{d'}$, and $\frac{A'^2}{A^2} = \frac{d}{d'}$.

Thus, if we double the polar area in this way, the travel is increased four times.

We see that l' differs more or less from the true length of air gap according to position of conical surfaces.

Inductance of Lines.

Mr. G. M. Warner informs us that his attention has been called to a numerical error in his article under the above caption in The Electrical World of July 14, page 27, which may mislead readers. The calculation of the inductance drop for a given case by an arithemetical is made to give a result of 107.5 volts instead of 123 volts, as it should be. By changing, however, the number of cycles from 125 as given to 109, the error will be corrected, and all of the other numerical results given will remain unchanged.

Electrical Muscle Making.

Some recent scientific researches, which can doubtless be trusted, show that the weight of muscles of animals was increased 40 per cent. by a proper periodic application of an electric current, the growth being a true development of the muscle. According to this it will now be possible to increase to order size of any desired muscle without tiresome gymnastic exercises, by simply lying in a soft chair and having the current applied. This, we suggest, might be done at night by an automatic apparatus, thus saving time. Persons who are improperly developed may now be balanced or "trued up;" muscles shrunken by age may now be made plump again. Calves, which nature or exercise has failed to develop sufficiently, will now no longer be a drawback to wearing knee breeches, or the short bloomers of the female bicyclist. The question naturally suggest itself, what will happen if this process of developing muscles electrically is continued still longer? If some way is then found to develop the bones the manufacture of giants by electrical means will be an easy matter.

Dynamo Electric Machinery—II.

BY EDWIN J. HOUSTON AND A. E. KENNELLY.

STRUCTURAL ELEMENTS OF DYNAMO ELECTRIC MACHINES.

Dynamo machines as ordinarily constructed consist essentially of the following parts; namely:

(1.) Of the part named the *armature*, in which the E.M.F. is generated. This is generally a rotating part, although in some

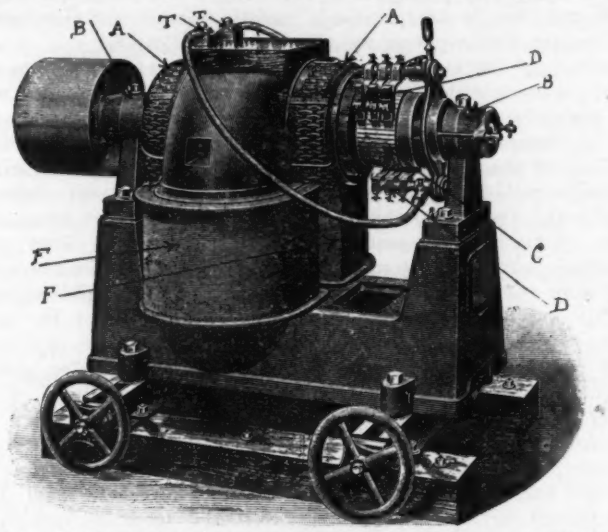


FIG. 1.—CONTINUOUS CURRENT BIPOLAR CONSTANT POTENTIAL GENERATOR.

machines the armature is fixed, and either the field magnets, or the magnetic field, revolve.

(2.) Of the part in which the magnetic field is generated. This part is called the field magnet and provides a *magnetic flux* through which the conductors of the armature are generally revolved.

(3.) Of the part or parts that are employed either for purposes of collecting and carrying off the currents produced under the E.M.F. generated in the armature, or for collecting and rectifying them,

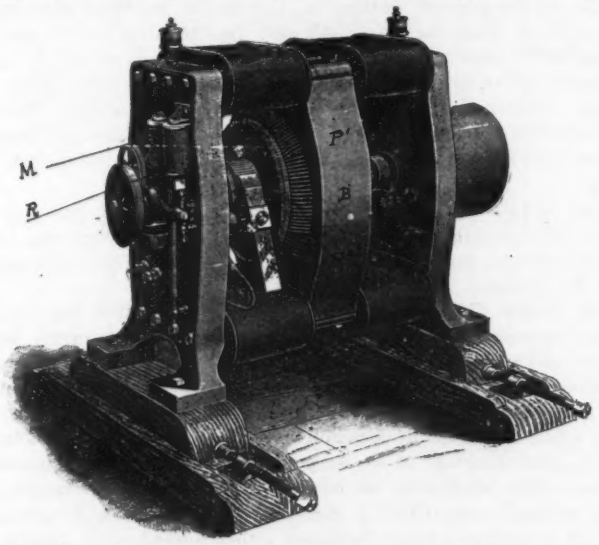


FIG. 2.—CONTINUOUS CURRENT BIPOLAR CONSTANT-CURRENT GENERATOR.

i. e., commuting them, and causing them to flow in one and the same direction as regards the external circuit. These portions are called respectively the *collecting rings*, when the current is not commuted, or the *commutator*, when the current is commuted.

(4.) Conducting collectors, consisting of a bundle of wire, or metallic gauze, or plates of carbon, pressed against the collecting rings or commutator, and connected with the circuit in which the energy of the machine is utilized. These are called the *brushes*.

In addition to the above parts, which are directly connected with the electrical functions of the machine, there are the necessary mechanical parts, such as the bearings, shaft, keys, base, etc., which also require attention.

The particular arrangement of the different parts will necessarily depend upon the type of machine, as well as on the character of the circuit which the machine is designed to supply.

It will, therefore, be convenient to arrange dynamo-electric machines into general classes, before attempting to describe the structure and peculiarities of the various parts.

10. Dynamos may be divided into the following classes—viz.:

(1.) *Constant-potential machines*, or those designed to maintain at their terminals, under all variations of load, a practically uniform E.M.F.

To this class belong nearly all dynamos for supplying incandescent lamps, and electric railroads.

Fig. 1. represents a particular machine of this type. A, A, is the armature, whose shaft revolves in the self-oiling bearings B, B. C is the commutator, and D, D, are sets of triple brushes pressing their tips upon the commutator. F, F, are the field magnets, wound

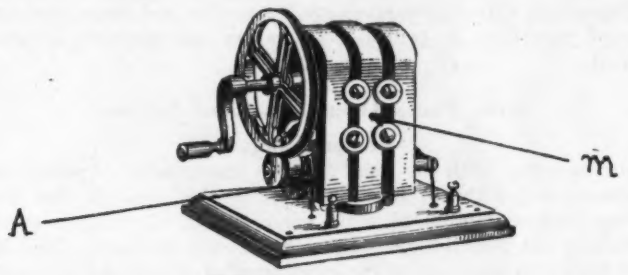


FIG. 3.—ALTERNATING CURRENT MAGNETO-ELECTRIC GENERATOR.

with coils of insulated wire. T, T, are the machine terminals, connected with the brushes and with the external circuit or load. The whole machine rests on slides with screw adjustment for tightening the driving belt.

Constant-potential generators are made in all sizes, and in various types.

(2.) *Constant-current* machines, or those designed to maintain an approximately constant current under all variations of load.

Constant current machines are employed almost exclusively for supplying arc lamps in series.

Fig. 2 represents a form of constant current generator. This is an arc light machine. It has four field magnets but only two poles, P^1 and P^2, connected by a narrow bridge of cast iron at B. At R is a

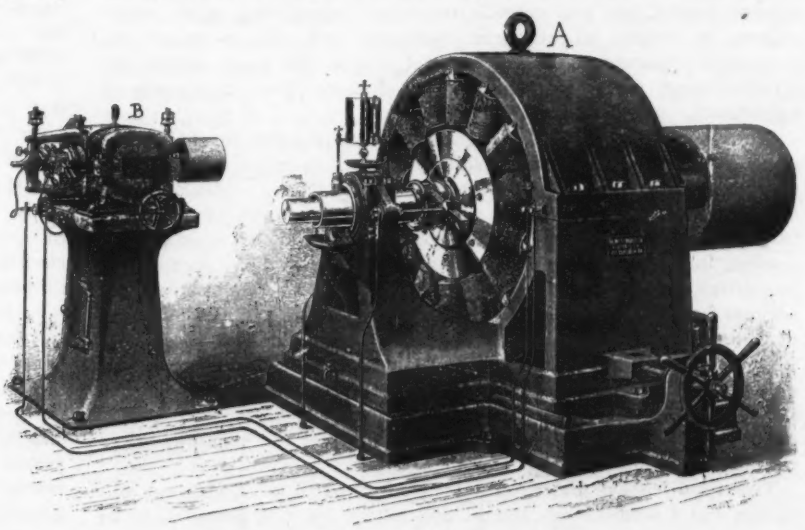


FIG. 4.—ALTERNATING CURRENT MULTIPOLAR SEPARATELY EXCITED GENERATOR.

regulating apparatus for automatically maintaining the constancy of the current strength by rotating the brushes back or forward over the commutator, under the influence of an electromagnet M.

Constant current machines are made for an output up to as many as 200 arc lights, i. e., about 10,000 volts and 9 amperes, or 90 kilowatts capacity. But such large sizes are exceptional.

11. Constant potential machines may be sub-divided into subclasses, according to the arrangement for supplying their magnetic flux—namely:

(a.) *Magneto-electric* machines, in which permanent magnets are employed for the fields.

The magneto-electric generator was the original type and progenitor of the dynamo or *dynamo electric* generator—but has almost entirely disappeared. It is, however, still used in telephony, the hand call being a small alternating current magneto generator, driven by a

handle. It is also used in firing mining fuses, also in some signaling and electro therapeutic apparatus.

Fig. 3 represents a form of magneto electric generator. M is a triple group of permanent magnets, and A is the armature.

(b.) *Separately excited* machines, in which the field electromagnets are excited by a separate electric source.

A particular form of separately excited generator is represented in Fig. 4.

Here a generator, A, has its field magnets supplied by a small generator, B, employed for this sole purpose. It is not necessary, however, that the exciting machine be used exclusively for excitation. Thus two generators, each employed in supplying a load, and each supplying the field magnets of the other, would be mutually separately excited.

Alternating current machines are frequently, and large continuous current machines in central stations are occasionally, separately excited. (To be continued.)

Some Facts About Polyphase Motors.*

BY LOUIS BELL.

In connection with the long distance transmission of power, most engineers will, I think, agree with me in the position that alternating current motors of some kind, and of alternating current, preferably the polyphase variety, are almost a necessity. We have been forced to their use by the exigencies of long distance service, which compel either the total abandonment of continuous current or its use under very embarrassing conditions.

There has, however, been a tendency to look upon the polyphase motor as a somewhat undesirable resort to which we have been driven by long distance work. Such, indeed, was my own belief from *a priori* reasoning, and before I had obtained that practical knowledge of the subject which can only come from personal experience both with the design and application of any class of apparatus. By such experience, and by the commercial demands which have been coming in with steadily increasing frequency, I have been forced into taking the position that the polyphase motor is intrinsically preferable to the continuous current motor for a vast majority of all the uses to which such machinery may be applied.

At present appearances indicate that not only will the polyphase motor displace direct current apparatus for most long distance transmission plants, but will prove a formidable competitor in all applications of motors to industrial purposes, and this, although the polyphase apparatus is the growth of only a few years, while the direct current motor is the outcome of more than a decade of experience.

We may, then, in instituting a comparison between polyphase and direct current motors, consider the various properties which a good motor of any kind must necessarily have. Mechanically speaking, we would all agree that it should be simple in construction, strong, not liable to frequent or considerable repairs, convenient in form and not excessive in weight. As regards its properties, it should in general run cool, stand overloading without serious danger, run at a nearly constant speed, or be capable of considerable variation in speed if necessary. It should be capable for certain uses of sudden and violent exertion, and of easily changing its direction of rotation. In a purely electrical way, it should be simple, efficient both at high and low loads, and should not take excessive amounts of current either in starting or in running.

This represents a difficult list of conditions to fulfil with any one motor, but I believe they can be met better by polyphase than by direct current machines. A direct current motor, for instance, of a given construction and reasonable weight, cannot run both at a constant speed, independent of load, in a particular case, and at the same time be capable of running at a wide variety of other speeds. It usually will not stand considerable overloads without sparking, and at the same time give a fair efficiency at low loads, and so one might go on piling up difficulties. The polyphase motor, too, cannot meet all these conditions with equal success, but examining them one by one, you will find that on the whole we can obtain very excellent results.

Taking up seriatim the desirable properties which I have enumerated, and applying them to polyphase motors, we find as regards the first count that their construction is singularly free from complexity. They consist in general of two concentric masses of lamination, forming respectively the fields magnet and armature. The armature is assembled on its shaft much as in direct current machinery, while the field laminations are held together by a clamping spider of very simple construction. The bearings are supported either on end spiders fitted to the field spiders by lathe work only, or on pillow blocks of the ordinary kind. Commutator and commutator connections there are none, nor should there be collecting rings except in rare instances. The armature need be exposed only to low voltages, and should preferably be wound with a comparatively small number of rather massive conductors, united at the ends either by a single plate or by very simple connectors, the latter form being preferable. The field winding is usually in a greater number of coils than is a direct current field winding, but each coil has a comparatively small number of convolutions, making the total winding by no means complicated.

In lieu of the starting rheostat of the direct current motor, we have a starting resistance which should preferably be placed within the armature, and consists of a few zigzags of metal united at one end and connected at the other to three or more contact pieces. A solid collar short-circuiting these contacts, and a forked lever to move the collar, completes the equipment, as I am accustomed to employ it. Its most noticeable feature is that the revolving armature, the most troublesome and delicate part of a direct current machine, is free from complication, and that it is almost as solid as if it were a solid mass of metal, and scarcely more liable to injury.

This very obvious simplicity of construction and mechanical strength is strong evidence of unusual freedom from repairs, and as a result of experience I have found that the induction motor is singularly free of liability to accidents of every kind. I have never succeeded even by the severest kind of experimental work in burning out a field coil or doing any serious injury whatever to a motor, although I have kept some of them on static torque tests in rapid succession for hours at a time, and have held them at rest and poured current through them until the leads burned off, the motor still remaining undamaged. If there is a test of extraordinary severity that I have not applied to induction motors, I have yet to learn of it. These properties are invaluable in commercial work inasmuch as they practically remove the danger of crippling the motor even under exceptionally unfavorable conditions.

As regards the convenience of the form of polyphase induction motors, I think an inspection of any of the types which have been brought out will render argument unnecessary.

The magnetic necessities of the case have led all makers of such apparatus in this country and elsewhere to adopt a species of barrel shape as the general outline of the motor, modified only in the proportions of diameter to length and in the adoption of one form or another of bearing. The tendency of this construction is to bring the centre of gravity of the machine very low, thus insuring unusual stability and freedom from general vibration. This form, too, enables one to place the motor in almost any position which is convenient in applying it, upside down, as a side bracket, and the like.

The largest installation of induction motors in the world, just put in operation in Columbia, S. C., aggregating over 1,200 h. p., is composed of inverted motors with their bases bolted to the ceiling timbers of the rooms.

As regards weight the abolition of any sparking limit to the output and the excellent magnetic material used might naturally be supposed to lead to motors of unusually light weight, and such is in fact the case. Sixty to seventy pounds per horse power in motors of moderate size is a figure easily reached without any sacrifice of efficiency, and if occasion requires these limits can be passed with great facility, 25 to 30 pounds of material per horse power being quite attainable in large units, while still retaining satisfactory general properties. I must say, however, that for most uses I do not consider extreme lightness either necessary or desirable, although it is important to be able to secure it if necessary. So much for the mechanical character of induction motors.

Electrically speaking, the case is just as favorable. Unless forced to a very large output per pound of weight, an induction motor will run quite cool, at a heating limit, in fact, below that of most direct current machines of similar weight and output. This advantage is mainly due to the very substantial character of winding which can be conveniently employed, and to the fact that the winding is distributed so that the losses in the copper are not localized, while the laminated character of the structure facilitates thorough ventilation. This freedom from excessive heating indicates that the polyphase motor can stand considerable overloading without any serious results, and experience has shown this to be the case. The worst that can really happen is that the motor may fall out of synchronism when the load is sufficiently great, thereby blowing the fuses in the primary line.

As sparking is obviated in this type of machine, it can readily be rated at such output as will give a proper limit of heating, and this output will in most cases allow from 30 to 60 per cent. of overload-

*A paper read at the Philadelphia meeting of the American Institute of Electrical Engineers.

ing before the machine will drop out of step. A wider range than this can be obtained if desirable, which it is generally not.

The limit of possible overloading fixes in a general way the possible static torque that can be obtained from a given machine, and this is apparently purely a matter of convenience in design, anything that can reasonably be required being quite attainable. There is no special difficulty in arranging polyphase motors for a starting torque four or five times the running torque, although this would be unnecessary except for severe hoisting and tramway work. At running torque the starting current taken may readily be no greater than the running current. From this it will readily be seen that a properly planned polyphase motor is easily capable of very great and violent exertions in a case of necessity. It will even endure complete reversal under full load within 10 or 15 seconds on motors of ordinary sizes, this time being sufficient for the machine to pass from full load in one direction to full load and speed in the other direction. This reversal is, as is well known, accomplished simply by reversing any two of the primary wires, the effect being to rotate the field in the opposite direction from the armature, thus causing an enormous rate of cutting lines of force, and consequently immense effort, causing the motor to stop and reverse.

SPEED VARIATION IN POLYPHASE MOTORS.

This subject has been for the most part in a rather hazy condition up to the present time. The induction motor has been generally known as non-synchronous, and such indeed it is. The name, however, has been frequently used in ignorance of the fact that an induction motor always tends toward synchronous running.

Under ordinary conditions the polyphase induction motor can be made to run at nearly constant speed independent of load, resembling in this respect a well designed shunt motor. A variation from no load to full load of 5 to 6 per cent. in speed would represent ordinary good practice, either in a shunt motor or a polyphase one, this limit being exceeded only in small motors or types which may be regarded as special. It is by no means difficult, however, so to design a polyphase motor that the speed shall possess very remarkable uniformity. This condition has been valuable in the Columbia plant previously alluded to. In this case tests of 17 motors showed a maximum variation in speed from an output of 75 h.p. to friction load of the motor, of only 2.2 per cent., individual motors showing slighter variations down to 1½ per cent.

The task of these particular motors is driving a cotton mill, hence the necessity for uniform speed. And this uniformity in speed is not greatly affected by variations in voltage, which would be quite sufficient to cause considerable speed variation in a shunt wound motor; in fact, the induction motor is remarkably insensitive to

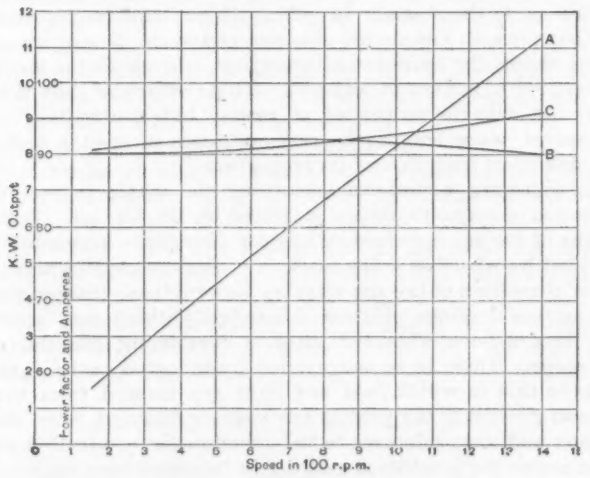


FIG. 1.

moderate variations in voltage, unless it is heavily loaded. This uniformity in speed has frequently been urged as an objection to the induction motor, barring its employment in cases where speed variation is necessary. This point is not well taken.

The induction motor cannot be made successfully to run at reduced speed by varying the primary voltage. Under these circumstances the output of the machine falls off somewhat more rapidly than the square of the voltage, so that only trifling speed variations are possible. It is a fact not generally known, however, that the speed of a polyphase motor can be varied with the same facility and within the same wide range as is possible in the case of a series wound continuous current machine, such as a railway motor. This is accomplished in the induction motor by a rheostat in the secondary circuit, just as it is accomplished in the series motor by a rheostat in the main circuit. Thus equipped, the two machines behave almost exactly alike. The speed at constant torque can be made to vary from full speed down to almost no speed, thus simulating the action of the series motor in the closest possible fashion. At any given speed an increase or decrease of the torque will decrease or increase the speed substantially alike in both classes of motors. In both, too, the efficiency is initially similar and falls off in practically the same ratio. A non-inductive resistance is necessary in case of the polyphase motor, an inductive one throwing the armature current so far out of phase as to interfere with the proper action of the motor.

Fig. 1 gives an excellent idea of the behavior of a polyphase motor with resistance in the secondary circuit.

Curve A shows the speed and output of a certain motor under these circumstances. It was a four-pole machine operated at 50 cycles per second, and the initial speed was reduced to 1,400 by

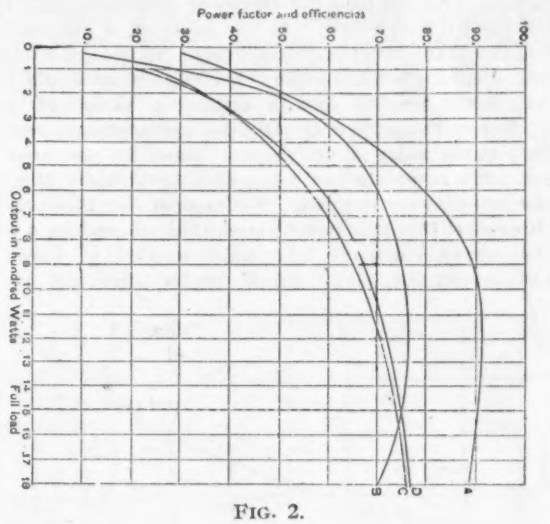


FIG. 2.

the resistance of the leads reaching across the room to the rheostat, composed of loops of manganin strip which could be systematically varied. It will be seen that the word curve is almost a misnomer, the ratio between the speed and output at constant torque being almost a linear function, even when the speed fell to as low as 150 revolutions per minute. It was not carried lower than this only because of lack of adaptability in the rheostat. No series motor could show a more satisfactory result.

Curve B shows the power factor under these varying conditions. It is high at all loads and speeds, varying slightly, with a maximum at about half speed.

Curve C shows the variation in current. This, as can be seen, is almost constant, falling off slightly at the lower speeds, the voltage being uniform throughout the test.

Speed variation by this method is not as efficient as might be wished, but still compares favorably with that obtained in a series motor with rheostatic control. Some modified methods of control promising a somewhat better efficiency have been suggested, but it seems probable that in the net result we shall find that continuous current and polyphase motors are about on a par in this respect. It should be noted that in continuous current motors, speed variation by weakening the field is only practicable within a very limited range, and requires an abnormally heavy motor. I think that with a similar change in design the polyphase motor could be made to operate nearly as well by change in its field strength. An efficient speed variation through a very wide range is attainable in either class of machine only by extraordinary means, as an elaborate combination of direct current machines, or frequently changing devices in the polyphase machines. From what has been said it will be apparent that the polyphase motor is perfectly capable of a complete control of speed on the same terms generally obtained with continuous current motors.

COMPARISON OF A POLYPHASE AND CONTINUOUS CURRENT MOTOR.

Fig. 2 gives a striking comparison between the properties of the two classes of machines under consideration.

The polyphase motor selected for comparison is of 2 h.p. output, representing the average small motor to be found in central station practice. This particular size weighs 218 lbs. complete, and runs at a speed of about 1,400 revolutions per minute on 50 cycles, loaded. It is relatively neither better nor worse than polyphase motors of other sizes, as may be seen by reference to the curves in my previous paper on this general topic. The power factor in this

case rises quite sharply, reaching 86 per cent. at half load, and through most of the working range of the motor remains at or near 90 per cent., nearly 91 per cent. as a maximum. The efficiency has its maximum a little under full load of the motor and reaches nearly 77 per cent., being 75 per cent. at full load. Both power factor and efficiency hold high values from half load up and do not fall off seriously until some distance below half load.

Contrast with curves A and B belonging to the polyphase motor, curves C and D; the former is the efficiency curve of a 2 h.p. 500 volt motor of one of the well-known American makes, and curve D is a similar curve for 2 h. p. 110 volt motor of European manufacture. These are not selected curves, but were the two completest available. Both these curves, C and D, show remarkable similarity. Neither of the motors sparked seriously at full load, the load limit being set rather by the heating. Both curves rise slowly and attain their maximum values at some point beyond the available load of the machine. At full load the efficiency is substantially the same as that of the triphase motor. At low loads it is noticeably worse. I think C and D are fair average machines. In tests of a wide variety of motors, some higher and some lower efficiencies would be found. Such, too, would be the case in testing a variety of polyphase motors. In fact the mate of the triphase motor shown, sent through the factory at the same time, showed about 1½ per cent. higher efficiency, but a complete test was not attainable, as the machine had to be immediately shipped. A comparison of these curves will render it evident that it is quite practicable to produce a polyphase motor having an efficiency fully equal to that of direct current motors of similar size, and I think the tendency will be towards

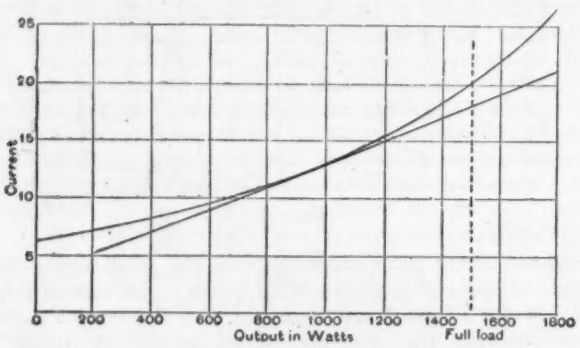


FIG. 3.

better efficiency at moderate loads. It should be mentioned here that the two horse power triphase motor was made of ordinary good armature iron, not selected or specially treated in any way.

Finally, let me call sharp attention to curve 3, which shows the effect of the power factor which, I regret to say, has been talked about not wisely but too well, in most of the discussions pertaining to polyphase apparatus. Two curves in Fig. 3 show the total current in the line in the 2 h.p. triphase motor and the 110 volt continuous current motor above mentioned. The current curve of the continuous current machine is nearly a straight line—that of the polyphase machine is almost tangent to it and slightly concave upward. A noticeable fact displayed is that throughout the ordinary working range of these two motors the currents were substantially equal, the existence of the power factor in the polyphase motor being only noticeable at very low loads and at overloads. This comparison should be a sufficient answer to the charges of excessive current that have so often been made against the polyphase machines. In a bad polyphase motor they would have foundation in fact. In a rather good one the net effect of the lagging current is trifling. It should further be noted that the current in this triphase motor at friction load is only about 30 per cent. of current at full load, and of this only 30 per cent. represents loss of energy. This is in marked contrast with the results obtained from a foreign triphase motor of similar size exhibited at the World's Fair, in which the no load current was nearly equal to that at full load and the power factor at full load was barely over 50 per cent.

In this brief discussion of some of the properties of modern polyphase motors I have endeavored to show how nearly they fulfill the conditions which may be regarded as desirable in electric motors in general. That they do so as well, if not better, than the continuous current machines of similar capacity I believe that I have satisfactorily shown.

The demand which certainly is arising for polyphase motors for general power purposes based on their intrinsic merits indicates that the older type of machinery has found a dangerous rival, all questions of long distance transmission aside.

Solar Electrical Energy Not Transmitted by Radiation.

Under the above caption Dr. M. A. Veeder, of Lyons, N. Y., has a paper in Vol. II. of the Rochester Academy of Science, in which he maintains that terrestrial magnetic perturbations are not of thermo-electric origin and have nothing whatever to do with heat or light radiations, adducing in support the facts that the maximum effect of magnetic storms are recorded on the dark side of the earth and that the auroras accompanying such storms, as seen in the Arctic regions at times, when daylight does not interfere with their observation throughout the entire twenty-four hours, appear on the side of the earth away from the sun.

It is true, Dr. Veeder states, that light rays may have electrical effects, as, for example, when they come in contact with selenium. This signifies nothing more than that ether pulsations may produce a certain amount of superficial atomic readjustment such as appears in photography. If, on the other hand, chemical or electrical action in their turn originate light rays, these have no power to transmit the very force on which their origin depends. Were it otherwise, an electric light would be a deadly thing. If the power of the current traversing the carbons were conveyed by radiation to surrounding objects, it would cause serious inconvenience if not death to any individual so unfortunate as to be exposed to its rays. As a matter of fact, however, there is no reception or dispersion of electric force by radiation, certain small vibratory motions of the ether only being conveyed by this means which produce certain electrical effects mechanically, which are wholly insignificant as compared with the force of the dynamo traversing the conducting wire.

All that we know about electricity, according to the views of Dr. Veeder, is that it is a property of atoms which after the analogy of chemical affinity causes them to combine pole to pole in such a manner as to satisfy what may be termed their electrical valency or power of entering into definite forms of adjustment in respect to each other. As well might we deny the existence of the attraction of gravitation, which does not appear to have any conceivable relation to ether waves, as to refuse to admit the existence of other forms of attractive force which may likewise be independent of ether waves and atomic oscillations of every sort. If only electrical currents were concerned it would be a question of motions, perhaps. The final outcome of electrical action is, however, an adjustment of stresses in particular directions having reference to poles and lines of force, so as to produce a state of equilibrium and consequent cessation from motion. To Dr. Veeder such a view appears to involve far greater difficulties than those sought to be explained. There is the question as to what must be the character of the motions of the ether that could accomplish such results, and the further question as to the manner in which these motions are sustained. With our present knowledge it seems preferable to assume, as the starting point, the existence of properties inherent in the atoms and independent of motion of any sort. To do otherwise than this is to resolve not only the properties of matter but matter itself into a question of wave length, the very existence of matter being unthinkable apart from that of its properties.

The following hypothesis concerning the whole process of the origination of magnetic storms is offered by Dr. Veeder: Particular portions of the sun's surface and cooler immediate surroundings are electrified by what has every mark of being volcanic action. The motion of rotation of the sun carrying forward these charged portions of its surface develops currents dynamically which act inductively along lines of force wherever there is conducting material within their scope. There is no conveyance by radiation or in a manner similar to that in which heat and light are emitted from the sun. The laws governing the process are entirely different from those of radiation and have reference to the principles of conduction as they appear under the conditions existing in interplanetary space. It is a mode of solar action that is distinct and that must be considered by itself. The final outcome of the temporary, sub-permanent and permanent effects of the electro-magnetic impulses thus originated and distributed is a magnetic system comprising within its scope the entire solar system and depending upon the properties of matter rather than of an ether simply. With this clue it becomes possible to trace out the modes of action and reaction and transference of stores of electrical energy in such manner as could not otherwise be done. Following this line of investigation it is already becoming quite certain that electromagnetic forces play a much more important part in the economy of the solar system than has heretofore been supposed. The physicist who has a clear apprehension of the nature of the properties of matter is the coming man in astronomy. The geometer has had his day.

Action of a Transformer with a Condenser in Parallel with the Secondary.

BY FREDERICK BEDELL AND ALBERT C. CREHORE.

In this article will be discussed the action of a transformer, across the secondary terminals of which is shunted a condenser. The condenser is, therefore, in parallel with the secondary load, which is supposed to be non-inductive, as would be the case with incandescent lamps. The problem will be treated in the same way as the various transformer problems given by the writers in a series of articles entitled "Theory of the Transformer," in The Electrical World, 1893. In these previous papers the action of a transformer has been investigated under various conditions, when supplied with a constant current and when supplied with a constant potential, the results for the latter case being in all instances derived from the results of the former, inasmuch as the graphical construction is simpler for the constant current case than for the case with constant primary electromotive force. The method for converting constant current diagrams into those for constant potential has been given for so many of these previous problems that in this discussion we will confine ourselves to transformers with constant primary current.

There are introduced here two new features not discussed in the previous articles: First, the presence of a condenser in combination with a transformer, and, second, a shunt circuit in parallel with the secondary circuit. Hitherto the secondary has been considered as a single circuit, all the current from the secondary of the transformer passing through the secondary load. It is now proposed to consider the simplest case of a divided circuit,

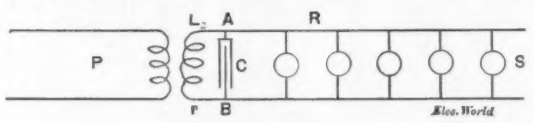


FIG. 1.

where the transformer secondary current divides, part passing through the condenser and part through the external resistance.

This problem is rendered easy by the use of graphical methods, for, although in the transformer we have mutual induction, yet, to construct the constant primary current diagram, we know that the impressed electromotive force upon the transformer secondary is equal to $M\omega I_1$ and is therefore a constant. This consideration reduces the matter to the simple case of the transformer circuit in series with a divided circuit; there is a constant impressed electromotive force, independent of the mutual induction of the transformer. Since this class of circuits has been already fully discussed in the writers' "Alternating Currents," Part II., it is thought to be sufficient to give one or two representative cases, where a condenser is used in combination with a transformer; and the method followed in this problem points to some general principles which will be useful in the many other similar problems.

The diagrammatical representation of the combination of transformer and condenser, which it is our purpose to investigate, is shown in Fig. 1. The primary circuit is denoted by P, and secondary by S. The condenser, C, is shunted between the terminals, A and B, of the secondary. The line resistance is R; the resistance and reactance of the secondary of the transformer are r and $L_2\omega$ respectively.

Since the impressed electromotive force upon the transformer secondary is $M\omega I_1$ we may, if we choose, represent the secondary circuit apart from the primary, as in Fig. 2. Here $M\omega I_1$ is a

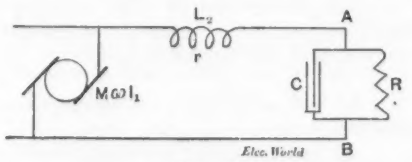


FIG. 2.

generator supposed to give an impressed E. M. F. $M\omega I_1$ exactly like the transformer, but supposed to offer no impedance to the current.

There are two methods which present themselves by which the solution of this problem may be obtained. One is the partly analytical and partly graphical, and the other entirely graphical. The former method will first be briefly indicated. The latter forms more especially the subject of this article.

DIAGRAM ESTABLISHED ANALYTICALLY.

The electromotive force $M\omega I_1$ impressed upon the circuit is the geometrical sum of two components; one to overcome the transformer impedance, equal to $I_t (r^2 + L_2^2\omega^2)^{\frac{1}{2}}$; the other to overcome the combination of condenser and resistance in parallel between the points A and B (Fig. 1). The equivalent resistance and capacity of circuits in parallel has been developed in the general case* where there are any number of branches to the divided circuit, and they may be thus expressed: The equivalent resistance is

$$R' = \frac{A}{A^2 + B^2\omega^2}.$$

The equivalent capacity C′ may be found from the expression

$$\frac{1}{C'\omega} = \frac{B\omega}{A^2 + B^2\omega^2},$$

$$\text{where } A = \Sigma \frac{R}{R^2 + \frac{1}{C^2\omega^2}}$$

$$\text{and } B\omega = \Sigma \frac{C\omega}{C^2R^2\omega^2 + 1}.$$

The summation gives one term for each of the branches. In the present case, where there are but two branches, and one branch contains no capacity, the other no resistance, the values of A and $B\omega$ reduce to

$$A = \frac{1}{R}; \text{ and } B\omega = C\omega.$$

This gives the values of R' and $\frac{1}{C'\omega}$:

$$R' = \frac{R}{1 + R^2C^2\omega^2}; \text{ and } \frac{1}{C'\omega} = \frac{C\omega R^2}{1 + R^2C^2\omega^2}.$$

The impedance of the combination of the divided circuits is

$$\left(R'^2 + \frac{1}{C'^2\omega^2}\right)^{\frac{1}{2}} = \left(\frac{R^2 + C^2\omega^2R^4}{(1 + C^2\omega^2R^2)^2}\right)^{\frac{1}{2}} = \frac{R}{(1 + C^2\omega^2R^2)^{\frac{1}{2}}}$$

The current through the transformer may now be found as follows: Replace the condenser and resistance branches by a single circuit, having resistance R' and capacity C', and we have now a simple circuit whose total impedance is

$$\left\{(r + R')^2 + \left(\frac{1}{C'\omega} - L_2\omega\right)^2\right\}^{\frac{1}{2}}.$$

The angle of phase difference between the electromotive force $M\omega L_1$ and the transformer current is

$$\text{arc tan } \frac{\left(\frac{1}{C'\omega} - L_2\omega\right)}{r + R'}.$$

Referring to Fig. 3, lay off OB equal to $M\omega I_1$ and make the angle BOV equal to the angle of phase difference obtained in

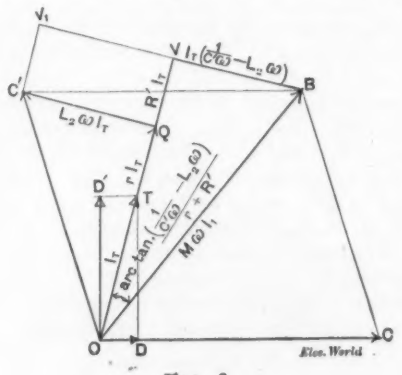


FIG. 3.

the last equation above. Draw BV perpendicular to OV. Let I_t denote the total current through the transformer secondary. Then OV equals $(r + R')I_t$, and $BV = \left(\frac{1}{C'\omega} - L_2\omega\right)I_t$. Divide OV by $(r + R')$ and obtain the current I_t, represented by OT. Also divide OV into two parts, OQ and QV, proportional to r and R' respectively. Then OQ is that portion of the impressed E. M. F. used for the transformer resistance. Draw QC′ perpendicular to OQ, in advance of it, and make it equal to $L_2\omega I_t$. Then OC′ is that portion of the impressed E. M. F., OB, which goes to overcome the transformer secondary impedance. Since OB is the sum of *two* components, OC′ for the transformer impedance, and a second component for the combination circuit, it follows that C′B, equal to OC, is the E. M. F. at the terminals of the divided circuit. The line current, OD, is necessarily in phase with the E. M. F., OC, at its terminals, and the condenser current, OD′, is a right angle ahead of OC. From T draw a perpendicular upon OC and upon OD′, and we have the transformer current, OT, the sum of the currents OD and OD′ in the line and condenser.

* See "Alternating Currents," pp. 303-308.

Thus, by the consideration of the equivalent resistance and capacity of divided circuits, we may easily find the relation between the E. M. Fs. and currents in the various branches. This, however, is not the way of looking at the problem that will most obviously give us the means to draw diagrams illustrating the manner in which the various quantities concerned change as we alter some one quantity. The method that lends itself more readily to this is, in our judgment, the entirely graphical method, which will now be explained.

DIAGRAM ESTABLISHED GRAPHICALLY.

It is our aim to construct the diagrams representing the changes which occur when the primary current is constant, while any one quantity, as, for instance, the line resistance or condenser capacity, is varied. As already explained, the constant current diagrams naturally precede the constant electromotive force diagrams, and are usually much simpler, inasmuch as the variations usually take place upon the arc of a circle. The constant E. M. F. diagrams may be directly derived from the constant current figures.

A constant primary current gives a constant impressed E. M. F., $M\omega I_1$, upon the transformer secondary. Any variation in one of the quantities of the secondary circuit will naturally cause the E. M. F. at the condenser terminals to change. If this condenser potential were to remain constant, it would be a very simple matter to draw the diagram of variations. It is proposed, first, to construct diagrams representing constant condenser E. M. F., and then to show how these may be changed to represent constant transformer impressed E. M. F.

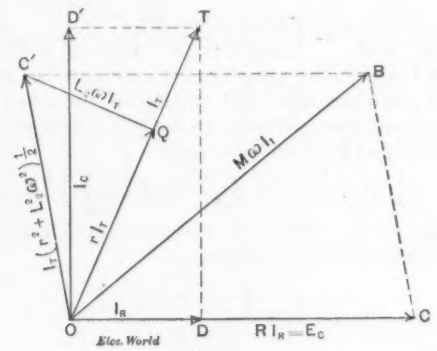


FIG. 4.

Let OC, Fig. 4, represent the constant E. M. F. at the condenser terminals, A and B (Fig. 1). Then the condenser current, OD′, is a right angle in advance of OC, and equal to $C\omega$ times OC. The line current, OD, has the direction of the electromotive force OC, and is equal to OC divided by R. The transformer current, OT, is the geometrical sum of OD and OD′. The E. M. F. for the transformer resistance is OQ, equal to OT times r. The E. M. F. for transformer reactance is QC′, equal to $L_2\omega I_t$, a right angle in advance of OT. The E. M. F. for transformer impedance is OC′, the sum of OQ and QC′. The total impressed E. M. F. in the transformer is the geometrical sum of the components OC and OC′, which is OB. This completes the diagram, and gives a figure like Fig. 3, obtained from the idea of equivalent resistance and capacity.

(To be continued.)

Suggestions for Transit Systems.—IV.*

BY S. D. MOTT.

REDUCTION OF SPEED WITHOUT GEARS.

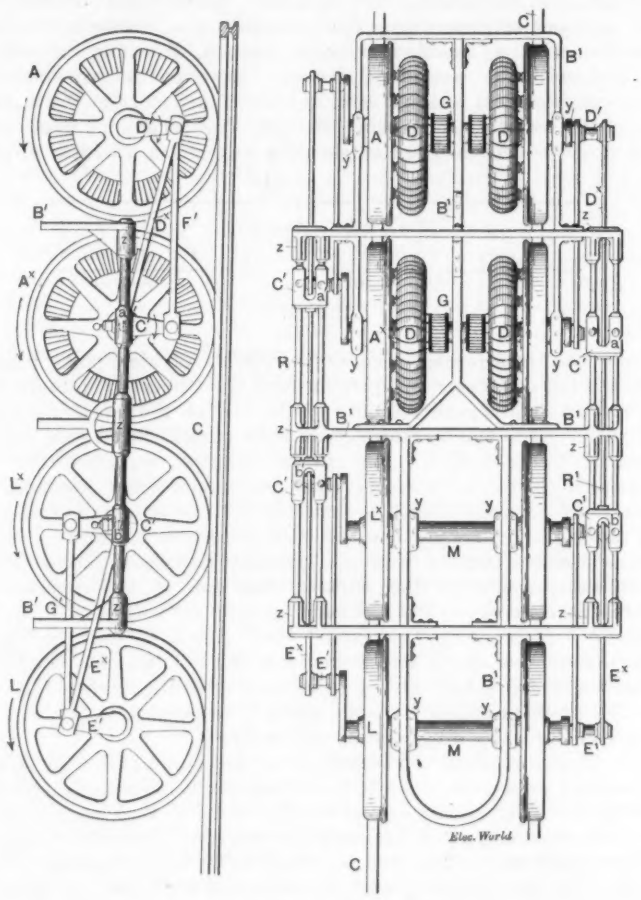
In the early days of electric traction development, one of the mechanical problems presented was the reduction of speed of the electric motor to the normal speed required for street car service. A mechanical solution of this problem necessarily involved a second important factor—that of overcoming the "vis inertia" of the vehicle by the small power or starting torque of the motor on the principle of the simple lever.

The first step of adaptation of the motor to the problem presented was, as would seem natural, loose belts and their tighteners and reduction gears, either cog or frictional. Belts and their adjuncts proved to be of little utility, and gears at that early period were far from what was desired.

In 1880 the writer devised a car equipment, the leading feature of which was a direct connection of the armature to the car axle, in combination with a form of car starting device, with the thought that the motors would prove adequate to propel and control the motion of a car or train after being started by extraneous or means other than electrical—the car was started mechanically and electrically controlled while in motion.

This arrangement, though simple, did not commend itself as commercial. I conceived there must be a way to multiply the small power of a motor into a greater force, sufficient for car driving, in a way analogous to the simple lever or closed train of gears, when great resistance or weight is overcome by an insignificant force. This presented itself as only a question of relative speeds for a given time, and there was plenty of speed, and to spare, but comparatively small pull or torque. The problem was to reverse this in a way that was practical, and to attain this end I was led to utilize the reaction of the motor; *i.e.*, allow the two elements of the motor, the armature and the field revolution, and then bring the dual reverse motion to bear at the same point of traction or another point, through other axles and wheels.

This, it was apparent—by the mechanical law that, in a closed train of mechanical elements, relative power or leverage changes, and is governed by relative speeds—would give double the pull of



FIGS. 1 AND 2.

the motor at the point of traction, other things being equal, because the two elements of the motor had twice the relative speed as when one element only revolved, and, *a priori*, *one* pound torque of the motor would, on the principle of the simple lever, give *two* pounds pull to the car.

The writer then devised a number of mechanical methods for reduction to practice. On some, gears were used; in others, no gears were used; and in still others, for special purposes, as bridge systems, etc., a cable was used. In some of these combinations, the statical, or moving pull, of the motor was capable of being still further increased by the purely physical action of the current up to any degree of useful application. The drawings illustrate two methods of motor equipment where the armature is directly connected to the axle, and at the same time the torque, or statical pull, is doubled without gears. This may appropriately be called a reacting or reciprocal driving equipment.

Fig. 1 is a side elevation and Fig. 2 a plan of such an equipment having four motors and four pairs of drivers, two pairs being motor drivers and two pairs reciprocal drivers, taking the reaction of the armature and reversing it through the connecting rods, parallel rods, crank pins, frame, bearings, etc. To avoid dead centres, the

* For parts I., II. and III. of this article see The Electrical World of April 28, 1894, p. 576; May 26, 1894, p. 719, and June 30, 1894, p. 873.

cranks on one side are set at ri ht angles to those on the opposite side—in fact, if the connecting rod R or R′ be substituted in the imagination for the piston rod of a locomotive, and the four motor wheels, or the four reacting wheels, be considered by themselves, there appears exactly the mechanical combination of the New York Elevated Railway locomotives, with the exception, of course, that the wheel drives the piston rod electrically, instead of the piston driving the wheels by steam.

The armatures are fixed to the axles, and the field magnets revolve with the wheels on the track. The four armatures are not

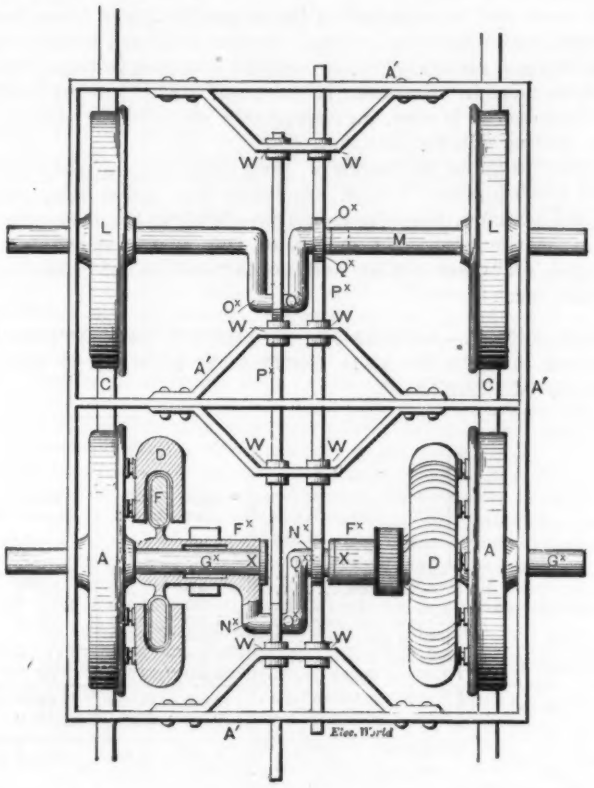


FIG. 3.

independent of each other, but are a mechanically closed train, while the fields are rotatively independent of each other, and the wheels with which they are connected will round curves without skidding the track.

Figs. 3 and 4 illustrate another method of reciprocal driving without the intervention of gears, having the same end in view as Figs. 1 and 2, but in this case using two pairs of drivers, instead of four.

Referring to these figures, A A are the motor wheels and drivers,

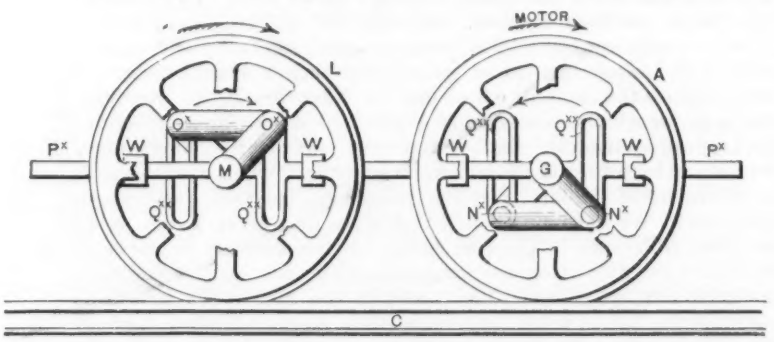


FIG. 4.

and L L are reciprocal drivers. In the driving wheel axle, M, are formed two cranks, O^x O^x, arranged at right angles. p^x p^x are reciprocating yoke bars, which have bearings at W W in a frame A′, mounted on the axles as shown. In the yoke bars are formed vertically arranged yokes, O^x O^x, in which play bearing boxes on the cranks of axle M. The axle G of the motor wheels is divided, and the divisions have heads, X X, on their inner or adjacent ends. On these divisions of axle G^x are rotatively mounted sleeves, F^x, which are connected by cranks, N^x N^x, formed with or secured rigidly to said sleeves. These cranks, N^x, have the same throw as cranks O^x, correspond to the latter in arrangement, as shown, and are set at right angles with each other. The yoke bars, P^x, are provided with yokes, Q^{xx} Q^{xx}, precisely like yokes Q^x, in which play bearing boxes or cranks N^x. The armatures, F F, are fixed each to a sleeve, F^x, and they rotate with said sleeve. The field magnets are fixed to and rotate with the wheels A. The long sleeves, F^x, rigidly connected by the cranks, N^x, so support the divided axle as to produce therein the effect of continuity, so far as stiffness and strength are concerned, but each wheel may act independently of the other.

Practical Notes on Dynamo Calculation,—XIII.

BY ALFRED E. WIENER.

28. Dimensioning of Commutator.

a. Diameter and Length of Brush Surface.

In low potential machines with small number of divisions, the thickness of the substructure determines the diameter of the commutator; in high potential machines, however, especially those of multipolar type, where the number of commutator segments is very great, the width, at top, of the commutator bars, their number, and the thickness of the insulation between them fix the outside diameter.

The bars must be large enough in cross section to carry the whole current generated in the armature without undue heating, and shall continue so after a reasonable amount of wear. They must be of sufficient length to allow a proper number of brushes to take off the current.

The same brush contact surface may be obtained by employing either a broad thin brush on a small diameter commutator, or a narrow thick one on a large diameter, the number of bars being the same in both cases, their width, consequently, larger in the latter case. With larger diameter and greater consequent peripheral velocity there will be more wear of both brushes and segments, and greater consumption of energy due to the increased friction of the brushes.

The segments are usually made of copper (cast, rolled or forged), phosphor bronze, or gun metal, sometimes brass, and even iron being used; the materials for the substructure are phosphor bronze, brass or cast iron.

From all this it will be obvious that a general formula for the diameter of the commutator cannot be established, and that, on the contrary, this dimension has to be properly chosen in every case with reference to the armature diameter to the design of the commutator, to the materials employed, to the strength of the substructure, or the thickness of the bar, respectively, and, finally, with reference to the wear of the segments.

The commutator diameter being decided upon, the size of the brushes can now be calculated, as shown in Section 29, and, from this, the length of the commutator can be found.

In order to prevent annular grooves being cut around the commutator, the brushes ought to be so adjusted that the gaps between those in one set do not come opposite the gaps in the other set.

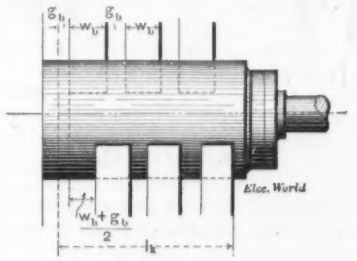


FIG. 39.

Denoting, Fig. 39, the width of each brush by w_b, their number per set by n_b, and the gap between them by g_b, we consequently obtain the total length of the commutator brush surface from:

$$l_k = \left(n_b + \frac{1}{2}\right) \times (w_b + g_b) \qquad (71)$$

This length of brush surface should be available even after the commutator has been turned down to its final diameter; the original diameter must therefore have a somewhat larger contact length. An addition to l_k of from ¼ to 1 inch, according to the depth of the bar, is thus necessitated.

b. Commutator Insulations.

In a commutator the insulation has to form a part of the general structure, and has to take strain in common with other material used; from its natural cleavage and hardness, therefore, *mica* is particularly suitable for commutator insulations, and is, in fact,

almost exclusively used for this purpose, only asbestos and vulcanized fibre being employed in rare cases.

The thickness of the commutator insulation ought to be proportional to the voltage of the machine, and, for the various positions with reference to the bars, see i, i', i'', Fig. 40, should be selected within the following limits:

TABLE XXXIV.—COMMUTATOR INSULATIONS FOR VARIOUS VOLTAGES.

	Up to 300 Volts.	400 to 750 Volts.	800 to 3,000 Volts.
Side insulation (i)	.020″ to .030″	.030″ to .040″	.040″ to .060″
Bottom insulation (i')	3/64 " 1/32	1/32 " 1/24	1/32 " 1/16
End insulation (i'')	1/16 " 3/32	1/32 " 1/8	1/8 " 1/16

29. Brushes and Current Leads.

a. Brushes.

The best breadth of the brush contact surface, with reference to the prevention of excessive sparking at the commutator, is that

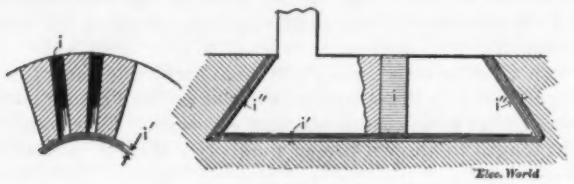


FIG. 40.

equal to the width of one commutator segment, Fig. 41. If, however, this would make the commutator too long, two bars may be covered by the brush, as in Fig. 42.

In the former case not more than one armature coil is short circuited at any time, while in the latter case two coils, at times, are simultaneously short circuited under each set of brushes.

The circumferential breadth of the brush contact may accordingly be expressed by

$$b_k = \frac{d_k \times \pi}{n} - i \qquad (72)$$

or, respectively, by

$$b_k = 2\left(\frac{d_k \times \pi}{n} - i\right) \qquad (73)$$

where:

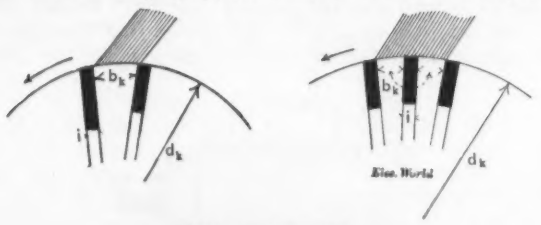
b_k = circumferential breadth of brush contact, in inches;

d_k = diameter of commutator, in inches;

n = number of commutator divisions;

i = thickness of side insulation, in inches (see Table XXXIV).

For copper brushes the result obtained by (73) should be the maximum breadth employed; for carbon brushes, however, where



FIGS. 41 AND 42.

the coils are short circuited through the comparatively high resistance of the carbon, b_k may be chosen so as to cover three bars of the commutator.

Having decided upon b_k by either one of the above formulæ (72) or (73) respectively, or having selected an intermediate value, the width of the contact area, and subsequently the width of the brushes can be found for a given current output of the dynamo by providing contact area in proportion to the current intensity. In order to keep the brushes at a moderate temperature, and the "loss of commutation" within practical limits, the current density of the brush contact should not exceed 150 to 175 amperes per square inch, in case of copper brushes (wire, plate, and gauze), and 30 to 35 amperes in case of carbon brushes.

The total axial width of the brush surface can, consequently, be expressed by

$$w_k = \frac{C}{150 \times b \times b_k} \qquad (74)$$

for copper brushes, and

$$w_k = \frac{C}{30 \times b \times b_k} \qquad (75)$$

for carbon brushes.

w_k = total axial width of brush contact surface, in inches;

C = total current output of dynamo, in amperes;

b = number of pairs of brush-sets (usually either $b = 1$, or equal to the number of pairs of poles, $b = P$).

For the purpose of securing a good contact, each contact surface should be subdivided into a set of n_b individual brushes, of a width w_b each, not exceeding 1½ to 2 inches. In small machines, where one such brush would suffice, it is good practice to employ two narrow brushes, even as low down as ⅛ inch each, in order to facilitate their adjusting or exchanging while machine is running.

b. Current Leads.

Care must also be exercised in the proportioning of those parts of a dynamo which serve to lead the current collected by the brushes to the external circuit. For, if material is wasted in these, the cost of the machine in unnecessarily increased and if, on the contrary, too little material is used, an appreciable drop in the voltage, and undue heating will be the result.

In order to guide the design of such parts, among which may be classed brush holders, cables, conductor rods, cable lugs, binding posts and switches, the following Table XXXV. has been prepared, which contains practical averages of the current densities to be employed for cross section and contact surface of the various materials used:

TABLE XXXV.—AVERAGE CURRENT DENSITIES FOR CROSS SECTION AND CONTACT SURFACE OF VARIOUS MATERIALS.

	Material.	Current Density. Square Mils per Amp.	Current Density. Amps. per Square Inch.
Cross section	Copper wire	500 to 800	1,200 to 2,000
	Copper rod	800 " 1,200	800 " 1,200
	Copper wire Cable	600 " 1,000	1,000 " 1,600
	Copper casting	1,400 " 2,000	500 " 700
	Brass casting	2,500 " 3,300	300 " 400
Brush contact	Copper Brush	5,700 " 6,700	150 " 175
	Carbon Brush	28,500 " 33,500	30 " 35
Sliding contact	Copper — copper	10,000 " 15,000	67 " 100
	Brass < copper	20,000 " 25,000	40 " 50
	Brass < brass		
Screwed contact	Copper — copper	5,000 " 8,000	120 " 200
	Brass < copper	10,000 " 15,000	67 " 100
	Brass < brass		

(To be continued.)

Sine Form of Curves of Alternating E. M. F.

To the Editor of The Electrical World:

Sir:—I have read with interest the comments reproduced in your columns from the London "Electrician" on those American engineers who are striving to build alternators giving perfect sine curves. The editor of that journal seems to take it for granted that such efforts are the result of being theory mad. I can assure you that in our case at least, although we do feel considerable respect for theory, our efforts were prompted solely by our experience of the advantages to be gained by such a construction. It may surprise the learned editor that we have found, for instance, that a motor which developed 40 h.p. when driven by a generator giving approximately sine waves was practically inoperative, scarcely able to turn itself over when unloaded, when working with an alternator of the same nominal frequency, but with very irregular waves. We have even found that there may be as much as 10 per cent. difference in the iron losses in transformers in favor of the sine wave alternator as compared with one of the ordinary irregular wave machines. The theory in the case of the motors is very simple, but as it has been more than once published, and as the editor of the "Electrician" calls in question its relation with the facts, I prefer to confine myself to the latter.

PITTSFIELD, MASS. JOHN F. KELLY.

Electric Coat Hooks.

According to a London contemporary, an Englishman has invented a clothes hook which is so connected with a battery and bell that when the coat or hat is removed the bell rings, thus warning the cloak room attendant. We suggest that for completeness sake a combined phonograph and loud speaking telephone might be added to call out the name of the owner, followed by "stop thief," and that a small detective camera might also be set off electrically to photograph the thief; the cloak room attendant might then be dispensed with, and his salary saved.

DIGEST OF CURRENT TECHNICAL ELECTRICAL LITERATURE

COMPILED FROM PRINCIPAL FOREIGN ELECTRICAL JOURNALS

BY CARL HERING

ELECTRO-PHYSICS.

Electrification of Air.—A Royal Society paper by Lord Kelvin and Mr. Maclean is published with illustrations in the Lond. "Elec. Rev.," July 20. The object of the experiments, which are described in detail, was "to find if a small unchanged portion of air could be electrified sufficiently to show its electrification by ordinary tests and could keep its electrification for any considerable time; and to test whether dust in the air is essential to whatever of electrification might be observed in such circumstances, or is much concerned in it." The apparatus is described and illustrated and curves of results are given; among other things "the curves show that the air does not retain a negative electrification so long as it retains a positive;" they found no appreciable difference in the ease with which the air could be electrified by discharges from a wire connected to the machine, and in the length of time the air retains its electrification. Some deductions are made regarding the electrostatic force of a cubic centimetre of air, and it is concluded that the "natural electrostatic force in the atmosphere, due as it is no doubt to positive electricity in very high regions, must exercise an important pondero-motive force quite comparable in magnitude with that due to difference of temperatures in different positions."

Atmospheric Electricity.—A note in the Lond. "Elec. Rev.," July 20, recommends the study of atmospheric electricity by means of balloons; a number of such tests have been made within recent years; the theory commonly held is that of Peltier, that the earth has a negative charge and is also surrounded by an electrostatic field, the equi-potential surfaces being approximately parallel to the earth's surface, the positive charge increasing with the height; the experiments of Weber, Elster and others appear to confirm this but a recent paper by Boernstein in the "Ann. Phys. u. Chem." states that there may exist in the atmosphere "masses" of elecricity of positive sign.

Photo-electric Action of Light.—The difficulties of working with ordinary polarized light in studying its photo-electric action disappear if the cathodes are formed of alkaline metals; an application of this is made by Dr. Elster and Mr. Geitel in a paper in the "Phil. Mag." for July and briefly abstracted in the Lond. "Elec. Rev.," July 20; experiments are described with a sensitive cell of the liquid potassium-sodium alloy; and the results are as follows: "The luminous electrical current attains its maximum when the electrical displacement in the luminous ray takes place in the plane of incidence, its minimum when they are at right angles thereto. In the former case the electrical vibrations contain a component normal to the cathode, but not in the second."

MAGNETISM.

Magnetic Rotary Dispersion of Oxygen.—A paper from "Nature," by Dr. Seirtsema is abstracted very briefly in the Lond. "Elec.," July 20.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Photometric Units and Quantities.—"La Lum. Elec.," July 7, contains an interesting article by Prof. Blondel, in which he suggests a complete system of photometric units and quantities. After pointing out that the photometric language and the number of units is insufficient, and stating that photometry has preserved without much change the phraseology which was used in the eighteenth century, he points out the imperfections of the present definitions. He shows that there exist six fundamental quantities (the seventh in the table being really equivalent to one of the others) which one has tried to replace with the aid of one single unit, the candle. He classifies these as shown in the adjoining table, discussing each one in detail. (The translation is suggested by the compiler, but the original French terms are given in parenthesis; a difficulty occurs in that the sixth one is termed, in French, "illumination," while the third one, "éclairement," corresponds to what is universally termed, in English, "illumination;" the compiler therefore suggests the term "quantity of illumination" for the former, in conformity with the similar term for the last one; unless some such distinction is made there would be some difficulty in the way of their adoption in English speaking countries; the compiler is also responsible for the indicated correction of the defining equation of the last quantity.)

Physical Quantities.	Symbol and defining equation.	Dimensions.	Names of practical units.
Luminous intensity (intensité lumineuse)	I	I	Pyr (or bougie-décimale=(1-20 violle)
Luminous flux (flux lumineux)	$\Phi = I\sigma^*$	I	Lumen
Illumination (éclairement)	$e = \frac{\Phi}{S}$	IL^{-2}	Lux
Intrinsic brightness (éclat intrinsèque)	$i = \frac{I}{S}$	IL^{-2}	Pyr per square centimetre
Intrinsic radiation (rayonnement intrinsèque)	$\Phi = \frac{\Phi}{S}$	IL^{-2}	Lumen per square centimetre
Quantity of illumination (illumination)	$j = e\,t$	$IL^{-2}T$	Phot (or lux-second)
Quantity of light	$Q = \Phi\,t$**	IT	Rad (or lumen-second), lumen-hour

* is a solid angle, its dimensions being a number.

** In the original this was $e\,t$, but it appears that it was intended to read $\Phi\,t$.

The luminous intensity is what corresponds to the usual term candle-power; the unit of luminous flux is the flux produced in a solid angle equal to unity from a luminous point whose intensity is one pyr, and for this he proposes the word "lumen;" a source having a mean spherical luminous intensity of n pyrs will then have a total flux of $4\pi n$ lumens; he discourages the use of the terms bougie metre, metre candle, foot candle, etc., and advocates the name "lux" proposed by Mr. Preece, a flux being defined as the illumination from a uniform source of one pyr of a surface normal to the rays at one metre distance, or as the illumination produced on the surface of one square metre by a uniform flux of one lumen; the product of a certain number of luxes by a surface expressed in square metres will then give a number of lumens; the intrinsic brightness (or perhaps better, specific brightness or specific intensity) has been used in two different ways, the more usual one being in the sense of the quotient of the intensity by the surface of the source, as shown in the defining equation in the table, in which case the practical unit is the intrinsic brightness of a source which has an intensity (candle-power) of one pyr per unit of surface, and therefore equal to one-twentieth of the brightness of the Violle standard; the other sense, which he calls intrinsic radiation (see table), is the ratio of the flux emitted and the surface of emission, as shown in the defining equation in the table, the unit in that case being a radiation of one lumen per unit of surface; both of these have the same physical dimensions; the next term, "quantity of illumination," which the author terms "illumination" in French, is the product of the "éclairement" (illumination in English) e, to which an object is exposed by the duration of the action of this illumination, the unit, lux-second, being that of one lux during one second; this quantity, which is an important one in photography, has been named by the Photographic Congress of Brussels the "phot"; the quantity of light should not be confounded with the flux, as it is the product of the flux by the time during which it lasts and is therefore a lumen-second, for which the name "rad" has been proposed by photographers; this unit can also be defined as the quantity of light received on a surface of one square metre submitted to the illumination of one phot; in practice the unit lumen hour could be used, corresponding to the term ampere hour in place of coulomb, and he suggests that in commerce light should be sold in terms of lumen hours; for a given wave length the quantity of light is proportional to the energy of radiation and it could therefore be measured in terms of the erg, like other forms of energy, but as this unit has no simple relation with the photometric effect, each radiation having a different co-efficient of physiological action, he prefers the system suggested. He then gives a number of examples of the practical applications, among others being a discussion of the application of these units to projectors, showing that thereby all confuson can be avoided. (The article is recommended to those who are interested in this subject.)

Measurement of the Pupil of the Eye.—An abstract of the paper of Mr. Henry, from the French, mentioned in the Digest, is published in the Lond. "Elec.," July 20, and discussed editorially in the same issue; it is pointed out that the sensitiveness of the eye is subject to great alteration caused by the changes in the diameter of the pupil; a low hanging arc lamp without diffusing globes would give a high photometric measurement, but the pupil would become so contracted that the eye would receive less light near the lamp than that which would be indicated by the photometer; methods for measuring the pupil of the eye are given, but it is stated in the editorial that none of them are such that the eye under test can be exposed to the illumination which is to be investigated, and it is suggested that a simple modification of the Robert-Houdin method might be adopted, in which this defect would be absent.

Precision of Electric Measurements.—In an article by Mr. Armagnat in "L'Ind. Elec.," July 10, he gives the following figures as the accuracy with which measurements may be made under the ordinary conditions of practice in a laboratory. The absolute ohm is known to 0.1 per cent., the ampere, the volt and the coulomb are known to the same degree of precision; the absolute value of the capacity of a good condenser of mica can be given to 0.2 to 0.3 per cent.; standard mercury ohms may be made to an accuracy of 0.001 per cent. and standards made of solid metal to 0.01 per cent.; resistance boxes are adjusted to a higher

precision than 0.05 per cent., but Wheatstone bridge measurements made with them rarely exceed a precision of 0.2 per cent.; currents can be measured to within 0.01 per cent. with the electro-dynamometer and the Thompson balance, but with tangent galvanometers it is impossible to attain 0.5 per cent. with a single observation; the electrolytic processes admit of a precision of 0.05 per cent; the errors in the use of the Clark cell are about 0.2 to 0.3 per cent.; ampere-hour meters rarely read closer than 1 per cent. and more often 2 to 3 per cent.; with a very constant current watts can be measured with an error equal to the sum of the errors of the amperemeter and the voltmeter; with a wattmeter the errors easily reach 1 to 2 per cent.; with good instruments and after making all corrections a better result than 1 per cent. cannot be guaranteed; the capacity of a good mica condenser can be measured to 0.05 per cent., ordinary condensers differing from 1 to 2 per cent. between two measurements; the co-efficient of self-induction of a coil without iron can be measured to 0.2 to 0.3 per cent., but with iron errors of 3 to 4 per cent. are easily committed.

Silk as a Dielectric for Condensers.—The Lond. "Elec.," July 13, abstracts from the Italian a paper by Mr. Lombardi, describing some completely successful experiments; the chief difficulty was in the humidity of the silk; with 100 rectangular sheets of tinfoil, 28 cm. by 18 cm. separated by double sheets of carefully dried silk (single sheets being subject to short circuiting), with a total thickness of 1.2 cm. a capacity of 0.351 microfarad at 21° was obtained, with an insulation resistance of 10,000 megohms; the sum of the residual discharges after one minute was a little over 3 per cent.; the measurements were repeated after seven months and gave slightly higher results; the temperature co-efficient of the specific inductive capacity was about one-thousandth per degree centigrade, positive for rising temperatures. Silk condensers may be safely used for all differences of potential commonly in use; with 500 volts from a battery a spark passed across the silk.

Measurements of Coefficients of Self-Induction.—The "Journal Télégraphique," June 25, contains a short article by Dr. Tobler, in which he describes a simple, practical method which is easy to apply and requires only cheap apparatus, the accuracy being from 1 to 2 per cent.; it is based on the method of Maxwell as modified by Vaschy la Touanne, Pirani and others.

Lightning Rod Testing Apparatus.—London "Electricity," June 22, describes and illustrates an apparatus made by Siemens Bros. & Co., consisting of a magneto-inductor and bridge.

Magnetic Curve Tracer.—The original of the article mentioned in the Digest last week is published in "La Lum. Elec.," July 14.

DYNAMOS AND MOTORS.

Sine Current Alternators.—The Lond. "Elec.," July 20, in discussing a recent editorial in The Electrical World, claims that notwithstanding the conclusions passed on the deductions of Kennelly and Duncan, they are by no means inclined to agree that there are sufficient grounds for the conclusions arrived at in the editorial; theoretical considerations are apt to ignore those influences, which, though difficult to put into exact mathematical form, are just the things which determine the truth or fallacy of the conclusions; referring to Dr. Duncan's researches it is claimed that the results were not compared with those which might have been obtained from any other alternator; it is asked whether there is anything to show that the motor was more efficient than it would have been in any other case.

Application of Small Motors.—A paper by Messrs. D. T. & A. C. Heap is reprinted and discussed editorially in the Lond. "Elec.," July 20. A diagram is given showing the switch arrangement adopted by the St. Pancras Vestry to induce customers to use motor power. A number of tables are given containing the results of tests of some existing plants, including the efficiency and the cost of the power under different conditions; among these are a Crompton compounded motor driving capstan, a Thomson-Houston shunt-wound motor of 15 h. p. for driving saws and planing machines, a Crompton series-wound motor for driving a hoist, another for driving chaff cutters, another for a meat chopping machine, and another for rivetting and drilling.

Dynamos Without Iron.—In an article by Prof. Pietzker, in the "Elek. Echo," June 16, he describes the principle and gives the theory of a dynamo without iron; it consists essentially of two drum wound armatures, one inside the other, revolving in opposite directions, or one revolving and the other stationary; each is provided with a commutator and brushes in the usual manner; there is no separate field; the brush lines make an angle of 90 degrees with each other; to start the machine a current is sent through the machine, after which the machine will excite itself; the two armatures may be connected in series or in multiple. In a small model, in which one was fixed and the other revolving at 3,000 revolutions, the current was one-eighth of that required at starting.

TRANSFORMERS.

Transformer Systems.—London "Lightning," June 21, contains an article by Mr. Sparks on alternating current transformers, in which he discusses the various systems and the importance of a number of factors in such systems and transformers. The Lond. "Elec. Rev.," July 20, contains another communication from Mr. Whitcher, giving, however, nothing of particular interest.

ARC AND INCANDESCENT LIGHTS.

Lighting.—In "L'Ind. Elec.," Mr. Hospitalier mentions some abstracts from a recent work by Mr. Marechal on the lighting of Paris, which he recommends very highly and which he says ought to be in the hands of every one who has to deal with lighting. He deduces the formula that the height of a lamp should be equal to 0.707 times the distance between the lamps, which will give a maximum light at the intermediate points; this formula always gives too great results for practice and therefore shows that lights are always placed too low to satisfy the conditions for the best illumination. He describes the following method for calculating the illumination on a point of a horizontal plane as P in Fig. 1 when the light is at L, and the curves giving the intensities at different angles are

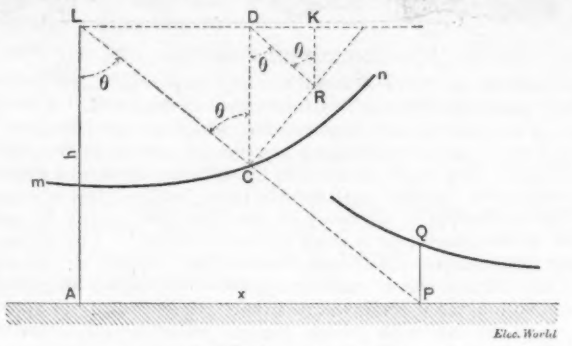


FIG. 1.—CURVES OF ILLUMINATION.

represented by the line MN. From the point P draw the line LP, then CD, then DR, CR, perpendicular to LP and finally KR, then the illumination at P will be equal to the distance KR divided by the square of the height h of the lamp above the plane; by choosing the scale of the diagram so that the square of h is equal to unity, the distance KR will give the illumination directly in metre-candles; by this simple graphical method the illumination may be found for any point, and the resulting curve of illumination Q drawn. He applies this method to showing what the photometric curve mn of a light should be, which when placed at a certain height gives a uniform illumination for a horizontal plane; this gives the conditions which should be fulfilled by burners, reflectors, globes, diffusers, etc.; the photometric curve with such apparatus should be as close as possible to that theoretical form; such curves are shown in broken lines in Fig. 2, 1 being for a uniform illumination of one

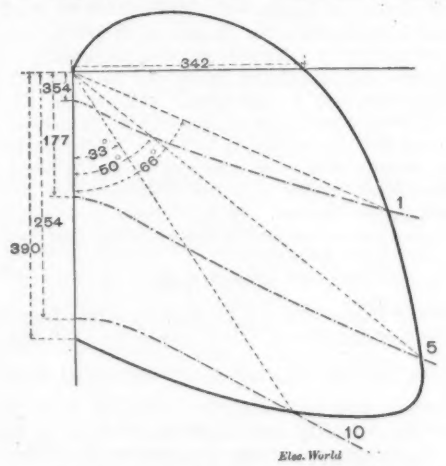


FIG. 2.—PHOTOMETRIC CURVES.

metre-candle on a horizontal plane at a height of 5.95 metres, curves 5 and 10 being for 5 and 10 metre-candles respectively; the full curve is that for an arc lamp with an opal globe. The illumination of surfaces such as a street may thus be readily calculated from the photometric curve of a source, the distance between the lamps and their heights; such illumination can be indicated by curves of equal illumination analogous to the contour lines of a topographical map. In conclusion he shows how the prices of illuminations produced under different conditions should be determined and compared; lighting depends on the duration, the surface and the illumination, for which quantities he uses the units hour, "are" (the French unit of surface, equal to 100 square metres) and the candle at one metre; the price of the lighting is then the sum paid divided by the lighting thus determined. Figures obtained in this way for a number of streets in Paris are given in a table and are as follows for the above named units and the centime as the money unit: with ordinary gas burners using 140 litres per hour, the price is 6.81; for regenerative gas burners requiring 750 litres per hour it is 3.65, while for 10 ampere arc lamps as used on a number of the boulevards, the average is 1.58, showing that the latter streets in which the arc light is used are lighted more economically.

Interior Lighting.—In a short note in "La Nature," June 16, it is stated that it is usual in computing the lighting of a large hall to make the number of candle power equal to one-half or one-third of the volume of the whole room expressed in cubic metres; it is thought that the former figure gives rather high results and the latter somewhat low, a

mean of the two being suggested as preferable; attention is also called to the fact that the effect depends very greatly on the furnishings of the room, the color of the walls, etc. Many engineers determine the lighting from the floor space, counting on between 2 and 4 candles per square metre, but this figure is often exceeded where the illumination is to be brilliant; it is stated that in a number of auditoriums in Paris the lighting varies between 6 and 30 candles per square metre of floor space, the former for a good illumination and the latter for a very brilliant one.

Incandescent Lamps.—Mr. Larnaude's paper (see Digest, July 28) is translated in abstract in an editorial in the Lond. "Elec. Rev.," July 20, but including apparently no editorial comments.

Coloring Lamp Bulbs.—In the serial in the "Elek. Anz.," July 12, on the manufacture of incandescent lamps, methods are described for frosting and coloring bulbs.

The Davy Arc Lamp.—This lamp, for which great compactness is claimed, is illustrated in the Lond. "Elec.," July 20.

TRANSMISSION OF POWER.

Series Transmission.—An article by Mr. Schulz, in the "Elek. Echo," June 23, describes an installation in which 15 h. p. was transmitted from a compound wound generator to a shunt wound motor, the system being a complete failure, owing to the use of an old steam engine whose speed varied very erratically; at certain times the motor would even reverse in direction; the motor and generator were then replaced by others containing series windings, after which the installation worked very satisfactorily notwithstanding the irregular action of the steam engine.

ELECTRIC RAILWAYS.

Railways in Germany.—The Lond. "Elec. Eng.," July 20, takes from the Foreign Abstracts of the Institution of Civil Engineers an abstract from a German engineering journal, comparing the cost of horse traction with electric traction in Germany; the figures are chiefly of local interest.

Electric Railways in the United States and Canada.—A paper by Mr. Wilkinson on this subject is begun in the Lond. "Elec. Eng.," July 20.

CENTRAL STATIONS, PLANTS, SYSTEMS AND APPLIANCES.

Gas vs. Steam for Central Stations.—Several correspondents to the London "Elec. Eng.," July 20, discuss the recent article in that journal on that subject (see Digest July 28 and August 4) and point out important errors and corrections, giving also other figures which are thought to be more correct; the correspondents argue in favor of gas and all conclude that if the figures are corrected the results will be in favor of gas, both in first cost and in working.

Alternating Current Station at Cologne.—London "Lightning," June 14, publishes a review of Mr. Coerper's book by Mr. Gisbert Kapp. Mr. Kapp calls attention to a clock in this station which is driven by a small synchronous current motor, the clock being therefore at any instant a correct measure of the engine speed; similar clocks are connected to the distributing mains at consumers' houses and must run synchronously with the clock in the engine room; the speed of the engines is governed so accurately that the clocks keep correct time; "that such a system of time distribution should at all be practically possible, is a proof of the exteme accuracy with which the engines are governed."

WIRES, WIRING AND CONDUITS.

Wiring Chart.—A double page chart by Mr. Sanders is published as a supplement to the Lond. "Elec.," July 20; by means of it most of the calculations which have to be made in wiring are made either by a system of co-ordinates and straight line curves, or by the direct comparison of a number of parallel scales and columns; the chart is based on current density as one of the chief elements; the use of the chart seems to be quite simple.

Short Circuits Caused by Lightning.—A correspondent to the Lond. "Elec.," July 20, states that Hertzian waves might start an arc between neighboring conductors during a thunderstorm, treating the matter as a serious danger; in an editorial it is stated that no instance of any arcing has occurred in ordinary house wiring and not a single fire has been recorded in England during a thunderstorm that could be attributed to electrostatic effect in electric lighting conductors.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Multiple Telephony.—The "Elek. Echo," June 30, contains a full description, accompanied by a large and quite complete diagram of connections, of the Nissl system, described briefly in the Digest June 2, in which any subscriber can connect himself with the station independently of the others.

Burglar Alarm.—A system is described and illustrated in the "Elek. Echo," June 30, in which threads stretched across windows, doors or passages, on being touched, removed a small insulating wedge from between two metallic springs, which on making contact with each other ring the alarm.

Time Distribution.—See abstract under "Alternating Current Station at Cologne."

ELECTRO-CHEMISTRY.

Electrolysis of Alkaline Chlorides.—Mr. FitzGerald, in a communication to the Lond. "Elec. Rev.," July 20, states that the E. M. F. is perhaps the main element which determines the cost of commercial elec trolysis; he states that there are but three materials at present available for the anode in the electrolysis of alkaline chlorides, namely platinum, gas carbon and lithanode. He quotes from a paper published a year ago in which he states that no evolution of hydrogen within the tanks should be allowed; it may readily be absorbed in the reduction of a metallic oxide economically regenerated by heating in air; no gaseous chlorine should be liberated; when, in the electrolysis of sodium chloride, both hydrogen and chlorine are liberated, 2.30 volts will be required, but when the hydrogen is absorbed only 1.61 volts will be required, while, when both the hydrogen and the chlorine are absorbed, 1.09 volts will be required. He enumerates certain conclusions to which he has come, among which may be mentioned that alkali and bleach must both be obtained, their simultaneous production being an economical necessity; that the alkali and the hypochlorate (bleach) must not be traversed by the current; he thinks that the conclusions can be realized in a practical form. (Mr. FitzGerald is the inventor of "lithanode," which is peroxide of lead in plates, and although not so stated, it is not unlikely that he refers to the application of this material.)

MISCELLANEOUS.

Chromium.—According to the Lond. "Elec. Eng.," July 20, Mr. Moissan has succeeded for the first time in obtaining chromium in a pure state in his electrical furnace; a sample of 40 lbs. of this rare metal was exhibited at a recent meeting of the French Academy of Sciences; he purifies it in the presence of a double oxide of calcium and chromium.

The Giffard Prize.—According to the Lond. "Elec.," July 20, the subject of the prize for 1896 will be "the transmission of power by electricity in various applications, machine tools, railways, tramways, bridges, ships, docks, etc. Those competing must commence the essay by a summary of the present condition of the subject, and give the details of some scheme which has been executed, or the draft of a suggested scheme."

World's Fair Awards.

Though the full report of the World's Fair Judges on insulated electric wires is not yet in the hands of the Awards Commission, the awards have been made public, and we are also enabled to print an account of the tests to which the various wires examined were submitted. The judges in this department were Professors D. C. Jackson, B. F. Thomas, R. B. Owens and M. O'Dea, and the tests ordered by the Awards Commission were as follows:

First, a breakdown test under high pressure to the point of rupture of the insulation, using a 2,000-volt Westinghouse alternating current.

Second, a soak test extending over a period of sufficient length to exhaust all but the best wire, which proved to be 100 days, the test ending to April 1, 1894. There were five solutions used, as follows: a, 10 per cent. sulphuric acid solution; b, 10 per cent. ammonia solution; c, a saturated lime water solution with heavy sediment of lime; d, a solution of subway refuse or scrapings from Chicago subways suspended in Chicago river water; e, Chicago hydrant water. The wire used was No. 14 B. & S. with $\frac{3}{32}$-inch insulation. There were ten varieties of commercial wire subjected to this test; two samples 100 feet long of each were used and tested at least once a week for resistance and the figures kept for computing the final results.

To these tests Prof. Jackson added a third, with the consent of the committee, which consisted of a combination breakdown and soak test. Five solutions made up as those in the second set of tests, were used, the wires being connected up in short lengths to a 6,000-volt current and kept in circuit until the insulation was ruptured.

Prof. Jackson and the other members of the committee are now preparing an exhaustive report on their work, but the results have been given out in advance, along with awards to the successful competitors. The first award is to W. R. Brixey for "Highest excellence in insulating qualities, durability of insulation under conditions found in commercial service, and uniform high excellence in mechanical qualities of insulation." Other awards were to the Okonite Company, New York Insulated Wire Company, Simplex Electric Company, Standard Underground Cable Company, and Norwich Insulated Wire Company. J. A. Roebling's Sons' Company received awards for bare copper and trolley wire and the Washburn & Moen Company for bare copper wire.

Government Test of Wire Cables.

Lieut-Commander Duncan Kennedy, of the U. S. Navy, a distinguished electrical authority, has written a report on his method of testing cables as applied to a specimen of double conductor cable manufactu ed by the National India Rubber Company, of Bristol, Conn., which most successfully withstood the test applied. After one month's immersion in salt water the cable was tested for insulation and found to have a resistance of 2,270 megohms per knot. It was then further tested by cutting off about ten feet and after putting knots and kinks in it and twisting up tight, a 300 pound weight was attached to the end. In one kink the outside braiding was torn, but it was impossible to tear it again though it was particularly tried. After this handling the same piece was put in a barrel of water and tested for continuity and leaks. No injury seemed to have been done to the wires or insulation. The copper wires were found to be tough and pliable and the tinning well done.

Mather Multipolar Generator.

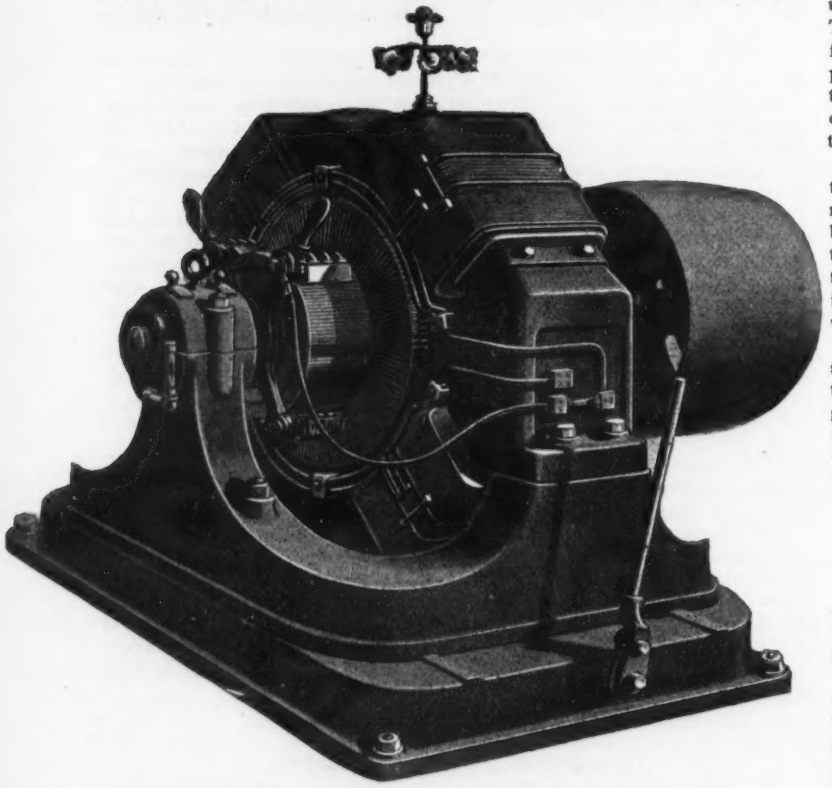
The generator we illustrate combines the results of the wide experience in the design of electrical machinery of the well-known Mather Electric Company, Manchester, Conn.—one of the pioneers in the electrical field. Embodying the most advanced ideas in design and construction, the claim that a corresponding increase in efficiency, durability and regulation under extreme loads has been attained with the new generator is one that rests upon a good foundation. It will be noted that the machines resemble in some respects the Thury type.

A point in the design of these generators of notable mechanical advantage is that the fields are cast in four pieces and entirely separate from the frame; these are bolted together, so that the time required for taking apart a machine to remove the armature and for reassembling is reduced to a minimum, and the work accomplished with the greatest of ease. The machines are designed to be belt-driven or direct connected to the shaft of the engine, and being reversible on their bed plates can be run in either direction at will by making a slight change in the connections. They are self-oiling, self-exciting, self-regulating, and, after being started require no attendance. The fields are compound wound and consequently the machines are entirely self-regulating, and equally well adapted for electric lighting, electric railway or power purposes. They are built in sizes from 30 kw. to 220 kw. capacity.

The railway generators are wound for a nominal voltage of 500, but, having a rheostat in the field circuit, the potential can be raised to 600 volts without undue heating, and even 50 per cent. overloads will be borne for short periods without injury to the machine.

The common difficulty with generators of sparking at the brushes, usually caused by the points of commutation shifting with variations in the load, has been entirely overcome; after the brushes have once been adjusted, further change is not necessary, no matter how sudden may be the variations in current. There is no sparking even with currents in excess of the rated capacity of the machine, and it is impossible to distinguish by watching the brushes whether the generator is loaded or not. The machines can be operated indefinitely at full capacity without any undue or dangerous heating anywhere.

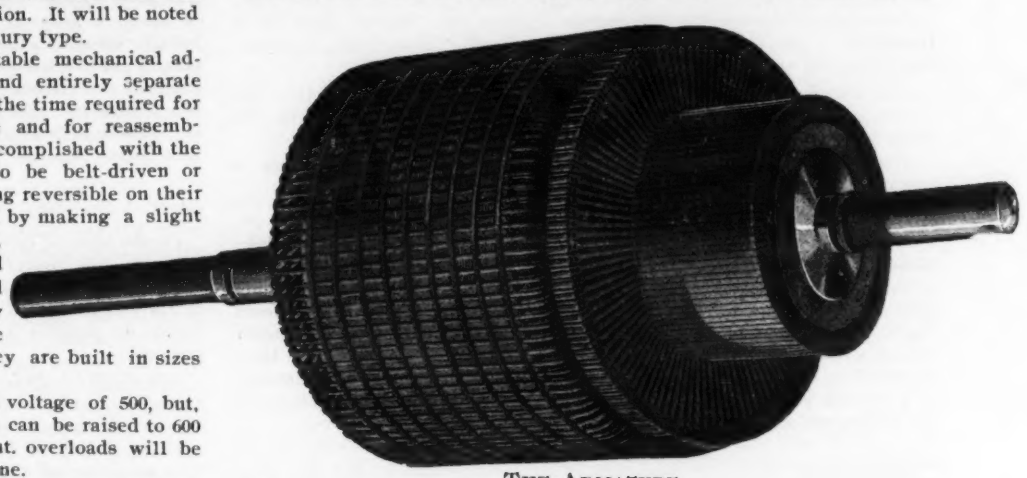
The bearings are self oiling, a large reservoir below each journal holding a quantity of oil, which is carried up on to the bearings by oil rings



Improved Multipolar Generator.

revolving upon the shaft. No attention to the bearings beyond a periodical examination and renewal of oil is required. Automatic alignment is secured by the use of ball bearings, which adjust themselves and can never bind on the shaft. The supports for the bearings and the entire bed plate are cast in one piece, a construction which gives great strength and rigidity to the bearings, and secures the greatest possible freedom from vibration. There are four sets of brushes, and each brush is held in an independent holder; hence any single brush can be raised from the commutator without disturbing the others, and, each having its own spring, may be perfectly adjusted. The diametrically opposite brushes are of the same polarity and are connected. The rocker arm of the brush holder is of rigid construction and the different parts are perfectly insulated; it is designed so that it will adjust all the brushes simultaneously.

The armature, which we illustrate, has a core built up with thin discs of soft iron which are forced together under pressure and rigidly keyed to the shaft. All washers are first treated to an improved annealing process peculiar to the Mather Company, with the result that the armatures when revolving in the most intense magnetic field will only heat up to a few degrees above the surrounding temperature. The greatest care is



The Armature.

taken in the insulation of these armatures. Before winding, there is fitted into each slot a carefully made duct of the best mica, through which the wire is wound. The simplicity of the winding is particularly noticeable at the end of the armature, where the wires, instead of being overlapped and bunched together, stand out from the core and from each other, thus allowing free circulation of air around every conductor. No wires having a large difference of potential are adjacent to one another. The necessary voltage is secured by revolving a comparatively small number of coils of wire in a powerful magnetic field, rather than by using a large number of coils and a weak field, as is the usual practice. The small amount of wire on these armatures accounts, in great measure, for the absence of sparking at the brushes, and the fixed position for the points of commutation under variations of load. No matter how great the current in the armature conductors, the field is always powerful enough to overcome the effect of their cross induction, and consequently the lead does not have to be changed.

The field consists of four steel castings rigidly bolted together and to the cast iron bed plate. The exciting coils are compound wound on metal bobbins, which can be readily slipped on or off by loosening a few bolts and raising one of the field castings. The fields are so compounded that as the current increases, the voltage rises sufficiently to make up for the loss of drop or for variation in speed. The employment of cast steel in the fields increases the efficiency of the machine much over what it would be if of cast or wrought iron construction.

The commutator, as will be noted, is of massive and substantial construction. The best drop forged pure lake copper bars are used, which, though more costly than cast bars, are preferable on account of their greater density, longer life and absence of blow holes or black spots in the metal. Great care is taken in the insulation, the very best mica being used throughout. By a peculiar construction it is an impossibility for any bar to work loose while the commutator is on the shaft.

Hydraulic Press for Covering Insulated Cables with Lead.

One of the most interesting inventions brought out by the development of electricity is the process of encasing cables, with lead, for the purpose of protecting them from mechanical injury, and also to exclude moisture, when laid underground, or used for submarine service.

The accompanying illustration shows a lead press recently patented by Mr. H. B. Cobb, general manager of the Chicago Electric Wire Company, Wilmington, Del., which embodies some unusual features and for which important claims are made. Hydraulic presses for covering cables with lead are quite old, the first being used in England something over fifty years ago, but not until now has it been possible to construct a machine that would satisfactorily cover a cable with lead of any desired uniform thickness or size, or with speed sufficient to be economical,.

Ordinarily enormous power is required to form a lead pipe, and herein the greatest difficulty presented itself to the successful machine, for the reason that the capacity was limited to the strength of the metal employed in its construction. Other defects also very materially retarded and reduced the capacity of the machine, such as the time wasted in heating the dies and blocks preparatory to starting the press and the long stops between charges to allow the lead to cool sufficiently to form the pipe. The changing of dies from one size to another was also a tedious and expensive operation.

The press herein illustrated entirely overcomes all of the serious objections mentioned, as will appear from the following description:

In covering cables with lead it is desirable and necessary to pass the

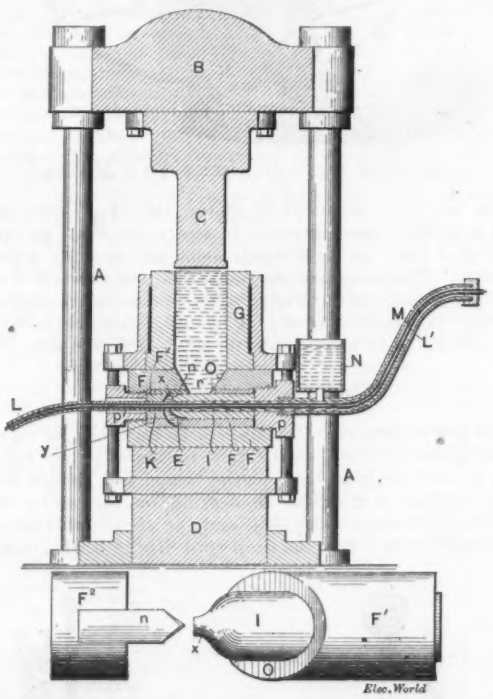
cable to be covered through the press horizontally or at right angles to the press, in order that the cable can be more readily handled. To do this great difficulty was experienced owing to the downward pressure of the lead against the dies which had the effect of throwing the dies out of centre or crushing them. To overcome this a bridge was interposed between the dies and lead cylinder. While this in a measure overcame the difficulty and protected the dies, yet the bridge obstructed the passage of the lead to the dies which rendered it necessary to have great heat and enormous pressure to form the pipe, making the process slow and expensive.

It will be noticed, owing to the peculiar formation of the die block, F, as shown, that the bridge above mentioned is entirely dispensed with and that the lead is unobstructed and free in its passage from the lead cylinder, G, to the dies I, K, having the effect of greatly reducing the power necessary to produce a lead pipe.

The reduction in the amount of power required made it possible to form the pipe from lead very nearly cold, in fact the only object in heating the lead at all is the convenience in handling it. The lead is introduced into the lead cylinder G in a molten state, but is at once cooled by cold water circulating around the cylinder and dies, reducing the temperature to less than 100 degrees or very near cold. When the pipe is formed the rapidity of cooling the lead avoids the usual long stops between charges of from two to five minutes to allow the lead to set sufficiently to form the pipe, the press starting the moment the cylinder is filled with the molten lead without regard to the size of the cylinder or the amount of lead it contains.

One of the great advantages in reducing the time between charges and running the lead so cold is to avoid any possibility of injury to the cable by excessive heat while standing still in the press.

Preparatory to starting a press to cover cables, it has been the practice and was necessary, owing to the amount of heat required, to heat the dies in the air block, C, to about 300 or 350 degrees by means of six or



HYDRAULIC PRESS FOR COVERING INSULATED CABLES WITH LEAD.

eight Bunsen gas burners, the time required to heat the same being from one to three hours according to the size of the block to be heated.

In the Cobb press invented the gas burners are entirely dispensed with and at no time does it require over fifteen minutes' time to start from a cold press.

The changing of dies from one size to another, often necessary, could only be accomplished in presses now in general use under the greatest difficulty and expense. A mild estimate of the time and labor required would be four men and one half day's time, while in the press illustrated the same work can be performed with two men in less than one-half hour.

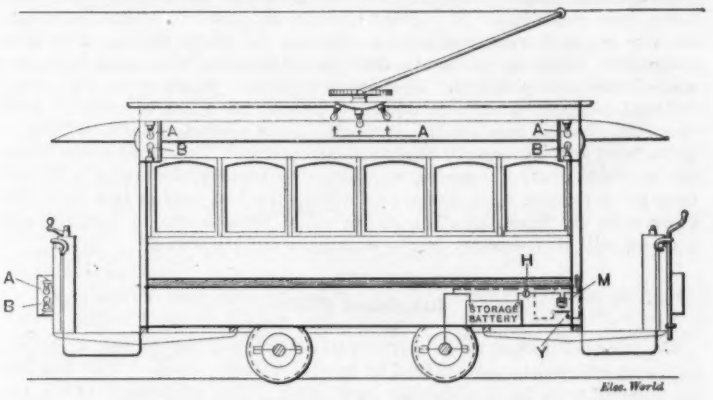
The press works with remarkable rapidity. In a recent case of a government contract for 200 miles of wire, $\frac{5}{16}$" outside diameter, the wire was encased with a $\frac{1}{64}$" covering at the rate of 50,000 feet per day. In another instance over 11,000 feet of No. 14 B. & S. wire was lead covered in an hour.

The great capacity of this machine, together with the precision with which it performs its work, has opened up a new field in electric wire covering. It has always been desirable to place upon the insulation of an electric wire a covering both water and fireproof. Various inventions in the line such as tape or braid saturated with a fireproof solution have been made. To cover the wire with a sheathing of lead has been known to accomplish the object, but the difficulty has been in finding a press that could make a lead pipe sufficiently thin, or rapidly enough to be able to compete with taped or braided wires. This difficulty has apparently been overcome by the invention of Mr. Cobb, and his company has entered the field with a wire encased in lead $\frac{31}{64}$" thick in competition with taped and braided wires.

The range of work which this machine can produce is as great as the rapidity of its action. Perhaps the smallest lead pipe ever manufactured was made on this press, the outside diameter being but $\frac{1}{16}$" while the diameter of the bore would just admit the insertion of a human hair or about $\frac{1}{1000}$. While this is the minimum size of pipe the machine can produce, the maximum size is about 2½" inside diameter, with the walls ¼" thick, which gives the press a scope sufficient to encase with lead the smallest and largest wire manufactured.

Electric Car Lighting System.

Upon the invitation of Mr. W. M. Miner, the electrical engineer of the American Manufacturing and Engineering Company, 143 Liberty street, New York, a number of gentlemen were given an exhibition on August 1 of a new electric street car lighting system as installed in a car at Hoboken, N. J. The visitors were taken aboard a car at the foot of the Fourteenth street ferry, Hoboken, and in running over the road the trolley circuit was frequently broken in order to show the value of this system in always keeping the car illuminated whether the trolley is on or off. The experts present expressed great satisfaction with the work-



ELECTRIC CAR LIGHTING SYSTEM.

ing of the system, no hitch whatever having occurred, notwithstanding the severe tests applied.

The system consists in the employment of a small storage battery of six Donaldson-Macrae storage cells, which are used to light a duplicate set of lamps should the trolley come off, or the motor current gives out or be interrupted in any way, the battery being switched on automatically when the motor circuit is broken. Referring to the illustration, a trolley current passes through the electromagnet M, which completes a circuit through incandescent lamps connected in series in the usual manner. The same current also passes through the storage battery, keeping it charged.

If the trolley comes off, the current gives out or is interrupted in any way, the armature of the magnet M is drawn back against its backstop, Y,, closing the supplemental circuit from the storage battery through the switch H to the armature of the magnet M, backstop Y, and lamps B, B, returning to the storage battery, thereby insuring light in the car whenever lights are required independent of the action of the trolley.

When the main circuit is restored by replacing the trolley or otherwise, the current takes its original course through the main circuit lamps, energizing the magnet M (drawing its armature away from the backstop Y), storage battery and ground, recharging the storage battery and lighting the car as before, thus automatically and positively insuring a constant light in the car under all circumstances. The extinguishing of lights in a public conveyance is so exceedingly annoying, particularly to ladies or timid persons, that this simple system of always assuring light in a car will doubtless meet with a wide appreciation.

A Large Electric Railway Plant.

The tendency for very large electric direct coupled generators, especially for railway power plants, has been illustrated again in a contract just closed between the West Chicago Street Railway Company and the Siemens & Halske Electric Company of America, for three 2,000 h. p. and one 1,000 h. p. generators.

A recent issue of the "Chicago Tribune" says: "The station is to be located on the property of the street railway company on Washington boulevard and Western avenue, a central location in the territory which is to be served. The station which will be constructed there is intended to ultimately accommodate five 2,000 h. p. generators and one 1,000 h. p., a total capacity of 11,000 h. p., which will make it the second largest in the country, and render it capable of moving 500 cars.

"Work is to begin on Van Buren street immediately. The line will have to be entirely rebuilt. About three miles of street will be converted

into electric line, the cars being taken at Halsted street and connected with the cable. The motor cars will be connected to the cable so there will be no delay. Mr. Chapman has devised a scheme for disconnecting the machinery in the motor car while the train is being drawn by the cable. The bids for the electric machinery calls for the completion of the first dynamo within four months of the award of the contract. The contract calls for the completion of an additional machine every fifteen days. The contract for the engines will be let immediately. The West Side power system is ultimately intended to operate electric lines on sixty miles of street, and the West Side company contemplates converting 120 miles of horse car lines into electric lines.

"The contracts for the construction of the North Side power house and for the engines and machinery were let recently. The power house will be located on the river opposite Sharpshooters' Park at California avenue and Roscoe boulevard. The station will ultimately have a capacity of 6,000 h. p. At present it is the intention only to operate 135 cars from that station, and the contracts which were let called for generators aggregating 2,800 h. p. Contracts for the engines were let to the Fraser-Chalmers Company, and for the electrical machinery to the Siemens & Halske Electric Company of America. The generators at the North Side station are intended to operate both North and West Side lines. The territory which will be covered will embrace all the lines of the North Chicago Street Railroad Company and will also furnish power for all the West Side lines north of North avenue. Power will also be furnished for a new line which is to be constructed on Elston avenue, from Chicago avenue northwest. This Elston avenue line is being built by the Chicago Electric Transit Company, a corporation that obtained an ordinance some two years ago. At present there is supposed to be no direct connection between that company and either the North Side or West Side companies, but it is intimated that ultimately the West Side Company will absorb that property. The entire electrical plants of the two street railroad companies embrace double tracks on 100 miles of street. It is expected that the first electric cars will be in operation early next year, and others will be rapidly equipped after that. The cross-town lines can be made ready to operate by electricity rapidly, for they will not have to be rebuilt. All lines laid within the last year or two were put down with the intention of changing them from horse to electric, and nothing will be necessary but to string the trolley wires."

Insulated Pliers.

We illustrate herewith a form of pliers designed for the use of trolley men and others who are obliged to handle electric wires. The handles are covered with hard rubber for insulation. The advantage which the pliers have over a rubber glove is that the latter is apt to slip and also becomes soft and porous with age and therefore useless as an insulator. The rubber used upon these pliers will neither become soft nor slip off

Insulated Pliers,

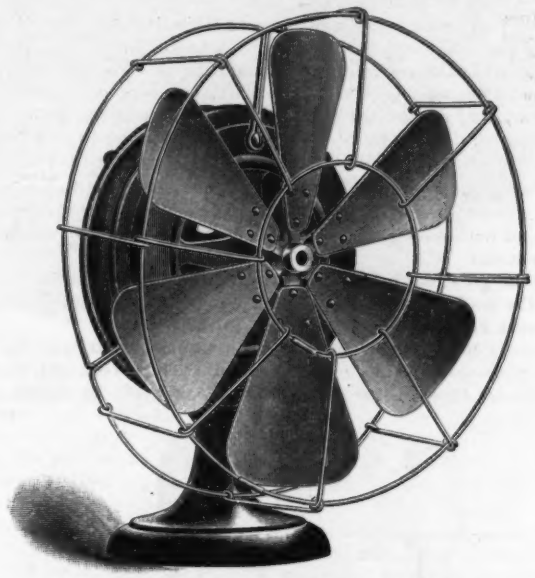
like a glove, nor will it break off; in fact it requires a hammer and chisel to remove it, and the rubber will stand boiling for five hours before it becomes soft. In view of these advantages over the rubber glove, its value is obvious to the electrician, who with it can handle any live wire with perfect safety. These pliers are made by Jacob Brombacher's Sons, 30 Cliff street, New York, under the name of "The Perfection Hard Rubber Insulated Pliers."

A Large Alternator.

At the works of the Fort Wayne Electric Corporation there is now running and being tested a new alternating current dynamo, the last of a series of iron clad alternators designed by Mr. James J. Wood, the company's electrician. This alternator, it is claimed, has the largest capacity of any single armature, compound wound, alternator constructed in this country, having one-fifth larger capacity than the big alternators exhibited at the Chicago Exhibition. The machine from the first has worked beautifully, and in every particular has more than met the expectation of the designer, and, so far as the workmanship is concerned, which is of the highest possible character, it reflects great credit upon the ability of the workmen who constructed it. The design is an artistic one, embodying all the beautiful lines and curves exhibited in all of Mr. Wood's apparatus, while the efficiency is considerably over 90 per cent. Judging from the operation of this alternator during the test, the company predicts a great future for it, believing that no person could see it work without being favorably impressed by its operation. It is capable of operating 6,000 16 candle-power lights and some idea of its size will be realized from the following statement of its dimensions: It is 16 feet long, 8 feet wide and 10 feet high, and weighs 31,000 pounds, producing a current of 150 amperes at 2,200 volts, and requiring an engine of 600 h. p. to drive it.

Alternating Current Fan Motors.

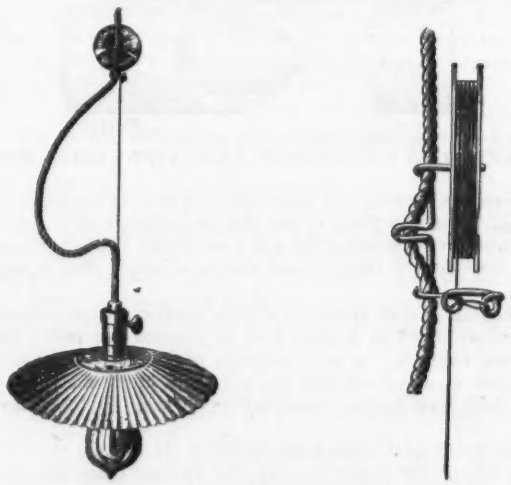
The General Electric Company has just perfected a fan motor for use on alternating current circuits. It is small and compact, and is constructed for any alternating current circuit of 52 or 104 volts. The armature or moving part is nothing more than a solid metal wheel hung on one bearing. It has no wires at all, no brushes, no commutators, no collecting rings, in fact no contact parts at all to cause trouble. The current from the transformer enters only a number of stationary field spools, which cannot burn out and which are entirely enclosed and protected. The fan is ten inches in diameter, has six blades and is protected by a polished brass guard. It starts as soon as the current is thrown on and runs at 1,800 revolutions, giving quite a powerful and cooling breeze. The height of the motor and fan over all is only twelve inches. The principal feature of this fan motor, contra-distinguishing it from all other fan motors, is that it is impossible for it to get out of order. It is finished in black japan on a broad stable base.



Alternating Current Fan Motor.

Cutter's Cord Adjuster.

In spite of the variety of automatic cord adjusters now on the market, the number in use is quite small, most of them being expensive and rather bulky, some fully as large as the lamps and shades whose height they adjust, so there is much to be desired on the score of neatness. What is more, it requires some skill and the use of tools to put them in place, and with most forms the drop cord has to be disconnected from the socket before the adjusting device can be put on. The device really needed, as shown by a growing demand for such an article, has been one which would be small and neat enough to be quite sightly and which could be quickly slipped on to the drop cord without the use of any tools. Such a form is now offered by Mr. George Cutter, of Chicago, its action being apparent from our illustration. It will take up about three feet of slack in the cord (which is enough to meet all ordinary requirements) and holds the lamp securely in any position. The device is nickeled and neat in appearance.



Cord Adjuster.

Financial Intelligence.

THE ELECTRICAL STOCK MARKET

NEW YORK, August 4, 1894.

THE ELECTRICAL STOCK MARKET is suffering somewhat from the lethargy cast on the market in general by heavy shipments of gold and the excessive hot weather, which is not conducive to activity in stocks. Though the market has been dull prices have held firm and in most instances scored slight advances.

WESTINGHOUSE ELECTRIC business reports are of an encouraging nature this week. The United Electric Light & Power Company, which, as stated in these columns, is to use eight of the Westinghouse World's Fair generators for electric lighting in New York City, has been reorganized without floating debt, and with ample capital for additional plant. In the reorganization plan it is said the Westinghouse Company has received bonds with a bonus of stock for its bills and accounts receivable against the United Company. The Westinghouse Company will receive its pay for the World's Fair apparatus in bonds and stocks on the same basis as cash subscribers. In this way the company will have in its possession bonds and stock to the amount of nearly $1,000,000. G. W. Hebard, second vice-president of the Westinghouse Electric Company, has been made president of the United Company. The reports from the Westinghouse Works show the same tireless energy on the part of the executive officials and in the efforts made to increase facilities in order to meet the increasing demand for Westinghouse apparatus. The price for lamps has recently been established at 25 cents for 16 candle power, with discounts as high as 20 per cent. The company has effected a deal with the Brush Electric Company, at Baltimore, whose station was burned. Former Brush preferred stockholders took 5 per cent. mortgage bonds and the Westinghouse Company received nearly all the common stock. The Westinghouse has sold the Brush people four generators of the same size as the World's Fair apparatus. Westinghouse common stock holds firm around 35 and there is now a bullish sentiment towards it.

GENERAL ELECTRIC has rather dropped out of sight as a security traded in either for speculation or investment. Sugar and a few railroads have monopolized the exchange market and General Electric has had an unusually dull week. It has scored ⅛ of a rise over last week's figures but it is due mainly to manipulation. Reports of heavy manufacturing by this company still continue, and Wall street is every day looking more favorably upon the stock. While the company's present claim of $1,000,000 gross business a month is not as much as what it has done heretofore, it shows the company is holding the lion's share of the electric business and with prospects of once more attaining its former position.

THE INTERIOR CONDUIT & INSULATION COMPANY paid its 5 per cent. scrip dividend on August 1. This company has done a splendid business in fan-motors this summer, and while the season is about over for this class of motor, the conduit people have large orders for their heavier machines. Stock quotations have not been lowered by the payment of a scrip instead of a cash dividend, and this security is held around 55.

THE EDISON ELECTRIC ILLUMINATING COMPANY of New York, paid its regular 1½ per cent. dividend August 1. This stock continues to range around par and is bought and sold very little at present.

THE EDISON ELECTRIC ILLUMINATING COMPANY of Boston, paid a 1½ per cent dividend August 1. Though this is the same rate of dividend paid as the New York Illuminating, the Boston stock is held firm around 120 and quotations have not changed for months.

WESTERN UNION TELEGRAPH has been comparatively active and scored a fraction of a rise for the week.

BELL TELEPHONE also gained a fraction over last week's quotations, but there have been no moves of the company that would have any bearing on quotations. Trading in the stock was very light.

ELECTRICAL STOCKS.

	Par.	Bid.	Asked.
Brush Ill., New York	50	10	30
Cleveland General Electric	100	80	90
Detroit Electrical Works	10	3	4
East River Electric Light Co.	100	—	50
*Edison Electric Ill., New York	100	96	98
* " " " Brooklyn	100	101	103
* " " " Boston	100	117	120
" " " Chicago	100	135	145
* " " " Philadelphia	100	122	124
Edison Electric Light of Europe	100	1	3
Edison Ore Milling	100	10	15
Electric Construction & Supply Co., com.	15	15	17½
" " " " pref.	15	15	17½
Fort Wayne Electric	100	1	2
General Electric	100	36⅛	36½
Interior Conduit & Ins. Co.	100	45	55
Mount Morris Electric	100	25	50
Westinghouse Consolidated, com.	50	35	36
" " pref	50	50½	51½

BONDS.

Edison Electric Ill., New York	1,000	106½	107
Edison Electric Light of Europe	194	75	85
General Electric Co., deb. 5's	1,000	86¼	86½

TELEGRAPH AND TELEPHONE.

American Bell Telephone	100	197½	198
American District Telegraph	100	—	45
American Telegraph & Cable	100	89½	90
Central & South American Telegraph	100	105	110
Commercial Cables	100	120	145
Gold & Stock Telegraph	100	100	102
* Mexican Telegraph	100	190	200
* Western Union Telegraph	100	85	85⅛

* Ex. div.

NEW INCORPORATIONS.

THE CHELSEA ELECTRIC LIGHT COMPANY, Chelsea, Mich., capital stock $25,000 has been incorporated.

THE BIDDLE RAILWAY CAR ELECTRIC LIGHTING COMPANY, capital stock $500,000, has been incorporated.

THE NATIONAL UNION TELEPHONE COMPANY, San Antonio, Tex., capital stock $50,000, has been formed.

THE PORTABLE ELECTRIC LIGHT AND POWER COMPANY, Orange, N. J., capital stock $100,000, has been incorporated.

THE STANDARD TELEGRAPH AND TELEPHONE COMPANY, Cleveland, O., capital stock $50,000, has been incorporated.

THE BROOKLYN GAS AND ELECTRIC COMPANY, Brooklyn, N. Y., has been incorporated with a capital stock of $10,000.

THE ARNOLD TELEPHONE COMPANY, Chicago, Ill., capital stock $100,000, has been incorporated by S. G. Arnold, M. F. Marsh and W. Howard.

THE HINSON MANUFACTURING COMPANY, Chicago, Ill., capital stock $500,000, has been formed to manufacture electric motors and railway rolling stock, etc.

THE RED LINE TRACTION COMPANY, Chicago, Ill., capital stock $50,000, has been incorporated. R. V. McNelhis, Frank Keogh and T. J. Hodkins are the promotors.

THE VANDERWERKEN, RICKERSON & BRAINERD COMPANY, New York, capital stock $20,000, has been formed by A. Vanderwerken, C. L. Rickerson and H. J. Brainerd to manufacture electrical apparatus, etc.

THE HARRISON INTERSTATE TELEPHONE AND TELEGRAPH COMPANY, Frederick, Md., capital stock $25,000, has been incorporated by P. D. Fahrney, J. Baumgardner, J. E. Walker, F. B. Sappington and E. L. Miller.

THE ST. GEORGE ELECTRIC COMPANY, LIMITED, St. John, N. B., capital stock $100,000, has been incorporated by T. H. Estabrooke, A. P. Barnhill and Dr. M. Bird, of St. John, and A. T. Dunn and F. B. Dunn, of Mushquash.

THE CITIZENS' ELECTRIC LIGHT AND POWER COMPANY, Appleton, Wis., capital stock $10,000, has been formed to transmit electricity for light and power. The incorporators are M. H. Creswell, A. C. Lansstadt and J. A. Paterson.

THE NIAGARA GAS SAVING COMPANY, Niagara Falls, N. Y., maximum capital stock $16,000, has been formed to manufacture and sell gas, electricity, etc. W. C. Edwards, W. H. Orchard, and J. D. Lapp, all of Niagara Falls, are interested.

THE ST. GEORGE ELECTRIC LIGHT AND POWER COMPANY, St. John, N. B., capital stock $5,000, has been incorporated. The incorporators are J. Sutton Clark, T. O'Brien, A. S. Baldwin, J. Frawley, Dr. H. J. Taylor, J. Vogue and J. O'Brien.

THE ARKANSAS VALLEY ELECTRIC COMPANY, Denver, Colo., capital stock $50,000, has been formed to furnish electricity for light, heat and power to various towns. J. W. Stearns, Jr., G. A. Goddard and J. E. Johnson, Denver, are the promoters.

THE UNITED GAS AND ELECTRIC LIGHT COMPANY, Saratoga Springs, N. Y., capital stock $50,000, has been incorporated by C. E. Arnold, of Albany, and E. J. Slattery and E. H. Peters, of Saratoga Springs, for the purpose of supplying gas and electricity.

THE STURGEON BAY WATER WORKS AND ELECTRIC LIGHT COMPANY, Sturgeon Bay, Wis., capital stock $35,000, has been formed to furnish electric light and power. L. M. Washburn, T. H. Smith, W. J. Binks, and W. A. Lawrence are interested.

THE F. D. POTTER COMPANY, Albany, N. Y., capital stock $1,000, has been incorporated by D. W. Potter, Woldoborough, Me., and Wm. J. Newton and Jos. Hutchinson, New York City, to deal in electrical apparatus and machinery and to carry on the business of consulting engineers.

THE COHOES CITY RAILWAY COMPANY Cohoes, N.Y., capital stock $50,000, has been formed to operate a street surface electric railway five miles long, in that city. The organizers are Urban Weldon, M. Hubbard, E. W. Lansing G. E. Simmons, J. Garside, T. O'Dea, H. Kahn, H. Graham, and G. H. Fitts, all of Cohoes.

THE YONKERS ELECTRIC RAILWAY COMPANY, Yonkers, N. Y., capital stock $1,000,000, has been formed to operate a surface electric road between Yonkers and New York. J. I. Bums, W. D. Baldwin, C. H. Montague, New York City; W. R. Hurd, Hartford, Conn., and D. N. Rowan, Irvington, N. Y., are the promoters.

THE SCENIC ELECTRICAL AMUSEMENT COMPANY, Jersey City, N. J., capital stock $25,000, has been formed to establish and operate scenic electric theatres and other electrical amusements. J. A. Seely, New York; P. J. Bennett, Brooklyn, N. Y.; W. H. Gandy, F. W. Roebling, Trenton, N. J., and C. H. Johnson, Montclair, N. J., are the incorporators.

THE ELECTRIC LIGHT, POWER AND WATER COMPANY OF SEA ISLE CITY, Sea Isle City, N. J., capital stock $50,000, has been organized to build and maintain electric, water, and other plants and stations for supplying light, power, heat, weater, etc. M. Boney, J. A. McCullough, J. McGuinness, J. Cowan, Philadelphia, Pa, and J. Haugh, Sea Isle City, are interested.

Special Correspondence.

NEW YORK NOTES.

NEW YORK, August 6, 1894.

G. A. BARNARD, superintendent of the Buckeye Engine Company, was in town last week on a business trip.

MR. P. S. BEMIS, JR., has resigned as Western representative of the Peckham Motor, Truck and Wheel Company.

ROLLEY LINE TO ALBANY.—It is reported that the electric road between Poughkeepsie and Wappinger's Falls is one link of a chain of trolley roads to connect Albany with New York.

C. S. VAN NUIS, 136 Liberty street, has recently received an order from a street railway company for 373,000 ampere capacity of Ajax switches, which is thought to be the largest order for switches ever placed for a similar purpose.

MR. MAXWELL M. MAYER, who designed all the new improved electrical apparatus for the Zucker-Levett Chemical Company, this city, and has occupied the position of electrical engineer for this company for the past four years, has

severed his connection, and is temporarily located at room 330, Electrical Exchange.

JOSEPH R. LOCKWOOD, president of the Michigan Electric Company, Detroit, has been spending a few days in New York recently. During a call at the offices of The Electrical World Mr. Lockwood stated that his company is receiving a very satisfactory number of orders for the extensive line of overhead material which it is now putting on the market.

ELECTRO-OZONE.—Commissioner Andrews is now considering a bid of $36,850 from the Wolf Electric Disinfecting Company for an electric disinfecting plant for Riker's Island. The city government is now paying the Wolf Company $128.57 a day, and $65 additional for each night to supply "electrozone" for disinfecting the island on a contract of three months from July 1.

MORTIMER NORDEN, manufacturer of fan motors, 136 Liberty street, met with a very serious accident while riding his bicycle last week near Fourteenth street, caused by his bicycle colliding with a heavy truck. Mr. Norden was struck in the breast by the tongue of the wagon with such force as to render him unconscious. He was taken to Bellevue Hospital, where his case is said to be considered very serious.

THE LARGEST ELECTRIC LAUNCH ever built in this country was shipped from the General Electric Launch Company's works at Morris Heights, N. Y., last week. The launch is 47 feet long, with oak frame, and hull, decks and cabin of polished mahogany. The boat has double screws, is propelled with two 4 h. p. motors and carries 136 cells of storage battery. Congressman Paul J. Sorg, of Ohio, is the owner. The launch will be used on Lake Chautauqua.

MR. CHARLES D. SHAIN, Eastern agent of the Siemens-Halske Company, while attempting to board a car on South street, New York, last Friday, fell and injured his right knee. Mr. Shain was taken to his office in a carriage where a physician found his injury serious enough to keep him at home for several days. The accident happened as Mr. Shain was on his way to Chicago to see about the company's plans since the burning of the Siemens-Halske works in the recent Chicago lumber fires.

MR. HENRY W. DARLING, who has been elected to the treasurership of the General Electric Company, was formerly a prominent dry goods merchant of Toronto, and was president of the Canadian Bank of Commerce, which has a capital of $7,000,000, and also five years president of the Toronto Board of Trade, which body under his administration became the leading commercial organization of the Dominion. Mr. Darling's business capacity has had a thorough test in the experiences of the General Electric Company for the past two years, and his selection for the position of treasurer confirms the impression he made upon this community as a man of extraordinary business ability.

New England Notes.

Branch Office of The Electrical World,
Room 91, Hathaway Building, 620 Atlantic Ave.,
Boston, Mass., August 4, 1894.

WATCH HILL, R. I.—In all probability the Electric Street Railway Company will supply Water Hill next season with electricity for lighting purposes.

MR. GEO. F. MANSON, general superintendent of the Okonite Company, of New York, was a Boston visitor this week and looked as smiling and happy as ever.

MANCHESTER, N. H.—The Brodie Electric Company has been organized in this city with a capital stock of $25,000. President, J. Brodie Smith; treasurer, Walter G. Africa; general manager, Albert L. Clough.

RAPID TRANSIT.—General Hyde favors electricity as the motive power of the Meigs elevated system, but Captain Meigs has all along insisted that this cannot be done with profit and maintains that steam must be used.

MAYOR MATTHEW'S nominee for commissioner of wires, John R. Murphy, has been confirmed by a unanimous vote. It is expected that great progress will now be made in burying the wires in Boston.

THE PETTINGELL-ANDREWS COMPANY, of Boston, have opened an office in New York city at 39-41 Cortlandt street. It is the intention of Mr. Andrews or Mr. Price or some one of their capable representatives to be in New York all the time.

THE BELKNAP MOTOR COMPANY, of Portland, Me., reports exceptionally good business. Its extensive addition to its factory is rapidly nearing completion, when it will be able to supply more quickly the demand for its manufactures, large railway generators and motors in particular.

THE BOSTON ELEVATED RAILROAD COMPANY (the Meigs road), has organized by the election of officers and directors: General Charles A. Whittier, now of New York, but an old resident and prominent business man of Boston, has been chosen president of the company. Captain Meigs was, of course, elected as chief engineer.

THE AMERICAN BELL TELEPHONE COMPANY has filed its return for expenses incurred during the last session of the Legislature. According to the return, it cost the company very nearly $50,000 to secure its $30,000,000 increase of capital stock and to protect itself from adverse legislation. The company paid to the press of Boston and vicinity more than $13,000 to have the arguments of Hon. John D. Long and R. M. Morse, before the Committee on Mercantile Affairs, published in full.

MESSRS. G. G. CROCKER and A. C. Burrage are the new subway commissioners for Boston by nomination of Gov. Greenhalg. Both of the gentleman are possessed of exceptional ability and integrity, and their nomination appears to meet with general approval. As counsel for the Brookline Gas Company and particularly for the Westinghouse Electric Company, in its issue with the Boston Electric Light Company before the Board of Aldermen, some years ago, Mr. Burrage is quite well and favorably known to the electrical fraternity.

MR. M. VON LOESECKE, a prominent mechanical and electrical engineer, has been engaged by the Davidson Ventilating Fan Company, of Boston, to manage its electrical and steam departments, and his valuable services will undoubtedly extend greatly its already excellent business. Mr. Loesecke has been actively engaged in the electrical business since 1881, holding responsible position, first with the N. E. Brush Company, leaving it to connect himself successively with the Thomson-Houston Company, the Thomson Welding Company and heGeneral Electric Company, all of which he served creditably.

Canadian Notes.

Ottawa, August 4.

OTTAWA, ONT.—The Ottawa Electric Street Railway proposes extending its line to Hintonburgh.

TORONTO.—A move is being made to extend a line of the Toronto Railway Company from the Junction to Weston.

TORONTO.—The Executive Committee has decided to call for tenders for machinery and plant for a civic lighting system. Lighting tenders are to be called also.

ST. JOHN, N. B.—Mr. Brothers says that the electric railway will employ from 350 to 400 men in laying the rails, and that the new line will be laid about the middle of October.

OTTAWA, ONT.—The Quyon, Coulonge and intervening points along the Pontiac & Pacific Railway are being connected by telephone. The contract has been given to the Bell Telephone Company.

GALT, ONT.—W. Y. Soper has handed over the newly constructed electric railway. The road is five miles long, the distance from either municipality being three miles. It is principally for freight purposes.

CALIDEN, ONT.—McLaren's mill here is to be run by electricity, generated over a mile distant at a water-power made by damming up a small stream, so as to give a good head of water. The dam is made of solid masonry, 25 feet high and very thick.

ELECTRIC RAILWAYS IN LONDON.—Work on the electric railway, which will run from Waterloo under the Thames into the city, has been commenced.

LONDON, ONT.—Mayor Essery has been in Toronto conferring with President Everett, of the London Street Railway. The City Council has refused to accept the company's latest offer for the electric franchise.

MONTREAL.—The next convention of the Canadian Electric Association will be held in Montreal next September. The convention will be held in the Mechanics' Institute Building and will last two days. The business part will comprise some important matters relative to the amendments to the constitution and by-laws. A number of important papers will be read and discussed.

SEAFORTH, ONT.—The Seaforth Electric Light Company is applying to the Ontario Government for a charter to establish a system of electric lighting and heating in the town of Seaforth. Capital stock is to be $25,000. Archibald Scott, James Scott and Francis Holmested are to be the first directors of the company.

MATTAWA, ONT.—The Mattawa Electric Light Company is applying to the Ontario Government for a charter for the purpose of establishing an electric plant in the town of Mattawa for lighting purposes. Colin Rankin, Chas. Hoeutschel, Robert Shanks, Louis Timmins and Robert Plow are to be the first directors of the company.

WINCHESTER, ONT.—W. R. Keating, of Kemptville, has been ascertaining what encouragement he could get in the matter of electric light if he were to establish a plant here. Sufficient lights were taken to about decide Mr. Keating to make a start. The Royal incandescent is the system. It is expected that he will begin operations about September 1.

TORONTO.—The first general meeting of the shareholders of the Toronto Suburban Street Railway Company was held here on the 31st of July, for the purpose of considering and confirming the agreements for the acquisition of the franchises of the City & Suburban Electric Railway Company, the Davenport Street Railway Company and the Street Railway Construction Company.

HAMILTON.—The quarterly check from the Street Railway Company has been received by the city clerk for the three months ending June 25, the amount being $3,325, made up as follows: Mileage, 1,000; percentage, at 6 per cent., on $29,168 of gross receipts, $1,750.08, less $25 on account of Herkimer street paving. For the same quarter last year the mileage was 1,404, and the percentage $1,729.
a. m. to 9 p. m., and to furnish the material for paving the streets traversed.

THE T. W. NESS ELECTRICAL COMPANY, Carleton Place, Ont., with a capital of $150,000, has just been incorporated in Canada. The applicants for incorporation are: Thomas Ness, Peter Davidson, James Rankin, John Adams, and Norman McLaren, all of Montreal. The company seeks power to carry on throughout Canada the business of manufacturing, buying, selling and trading in every description of electrical apparatus and appliances.

MONTREAL.—The next convention of the Canadian Electric Association will be held in Montreal in the latter part of September. The convention will be held in the Mechanics' Institute Building and will extend over three days, one business session being held on the first day and one in the forenoon of the third day. The papers that will be brought before the convention include a paper on "The Possibility of Securing Better Regulation at Central Light and Power Stations by Means of Fly Wheel Accumulators of Improved Construction," by John Galt, C. E. and M. E., Toronto; and one on "A Method of Distribution with Equalization of Potential Difference," by D. H. Keeley, of the Government Telegraph Service.

THE CHAUDIERE ELECTRIC LIGHT AND POWER COMPANY, the Standard Electric Company and the Ottawa Electric Light Company, which have done business in Ottawa for many years, have ceased to exist separate as corporate bodies. Under the power received from the Dominion Government they amalgamated into one company, under the name of the "Ottawa Electric Company," which will carry on all the business of the former three. The authorized capital stock of the Ottawa Electric Company is $1,000,000, and the paid-up stock is $645,000. The Board of Directors of the new company are Thomas Ahearn, Hon. E. H. Bronson, M. P.; G. P. Brophy, G. B. Pattee, C. B. Powell, J. W. McRae, Robert Blackburn, Hon. Francis Clemow and William Scott.

English Notes.

(From our own Correspondent.)

London, July 24, 1894.

THE CITY & SOUTH LONDON RAILWAY.—The only interesting feature about the report of the directors of the City & South London Railway Company for the half year ending June 30 is the announcement that the company's engineer has been instructed "to make experiments with the view of substituting motors on the train itself in place of the present separate locomotive." As the running expenses per train mile have now become stationary at 6.2d, and the yield per train mile is also of a stationary character, the adoption of motive cars in place of separate locomotives would appear to be the only available engineer-

ing means of increasing the net income, at any rate until the extension northward has been carried out.

THE TELEPHONE AS A TELEGRAPH.—It is now some thirteen years ago that Mr. Justice Stephen decided that, in the eyes of the law as set forth in the telegraph acts Prof. Graham Bell's invention was a telegraph, and within the last few months the Post Office has taken steps to transform this legal fiction into a solid fact. The Post Office electricians are now busy all over the country, substituting telephones for the A. B. C. and needle instruments, which form the usual equipment of our country telegraph offices. The manipulation of the A. B. C. telegraph is, in all conscience, sufficiently simple, but with a view of enlisting in the telegraph service the whole family of every rural postmaster, the telephone is being substituted. If our telegrams from rural districts are to be transmitted verbally in future, important messages will have to be couched in simple words suitable to the idiosyncracies of the telephone, unless the recipients are to get a revised version of the messages sent.

News of the Week.

TELEGRAPH AND TELEPHONE.

SHARPTOWN, MD.—Address A. W. Robinson & Co. concerning estimate of cost for a nine-mile telephone line.

CORSICANA, TEX.—Address James I. Autry concerning a telephone equipment about to be purchased. A company is organizing to construct the telephone line.

WOMELSDORF, PA.—George Filbert has been elected president of the Groff Telephone Company, with main office in the Borden Building, Chicago, and the eastern office at Womelsdorf. The new company has been organized under the laws of Illinois and capitalized at $1,000,000. Elias Groff, treasurer, and William Filbert, secretary. Other officers who are Chicago men are W. B. Brissel, vice-president; I. B. Tabor, assistant secretary, and W. F. Bigelow, attorney.

ELECTRIC LIGHT AND POWER.

LANMARK, ILL.—A franchise is being asked for to put in an electric plant.

IOWA FALLS, IA.—Address the Mayor concerning a contemplated electric light plant.

WELLS, MINN.—The city voted to issue $20,000 in bonds for water works and electric lights.

MT. PLEASANT, IA.—The Council is considering the question of electric street lighting.

STOCKTON, N. J.—Councilman Gramer favors the town owning its own electric light plant.

MARION, IA.—The Council has granted to F. J. Hodges a franchise to put in an electric plant.

HUNTINGDON, N. Y.—Standard Gas and Eectric Light Company is reported in the hands of a receiver.

MIDDLETOWN, O.—The city is advertising for bids to light the city and city building with electric lights.

LE ROY, N. Y.—Le Roy will have a new electric plant to be put in by F. C. Rogers & Co., lumber dealers.

ROME, N. Y.—Address C. A. Fowler concerning proposals to furnish the city with 150 arc lights for one, three or six years.

ALLEGHENY, PA.—The city engineer has been authorized to advertise for bids for machinery for the electric light plant.

PALMYRA, N. Y.—W. D. Willcox, of Earlville, has secured a $10,000 contract for constructing an electric lighting plant here.

TEXARKANA TEX.—Bids will be received for a franchise for a system of water works and electric lights. P. A. Turner is mayor.

GLADWIN, MICH.—The Council on July 21 granted Messrs. Prindle & Schulz a franchise for thirty years for electric lighting and power.

CONCORD, N. C.—An electric pumping system will be put in by the Odell Manufacturing Company. F. L. Emery is superintendent.

VINELAND, N. J.—The Norton Parker Company have decided to run an overhead trolley in the foundry to carry iron around the building.

PATTEN, PA.—A scheme is on foot whereby Carrolltown, Hastings and Patton are to be lighted by electricity from a plant in the latter town.

SARATOGA SPRINGS, N. Y.—The United Gas and Electric Light Company, of Saratoga Springs, was incorporated with the Secretary of State.

GREEN LAKE, WIS.—Green Lake people are talking of putting in an electric light plant to light the resorts and furnish power for launches.

LAPEOR, MICH.—The Electric Lght Company is preparing to erect new poles, put in a new engine and dynamos and otherwise improve the plant.

CARDINGTON, O.—Proposals will be received for an electrical light plant complete, or engines and boilers separate from the rest of the plant.

ST. LOUIS, MO.—Supervisor of City Lighting A. J. O'Reilley is preparing plans for the location of 50 additional incandescent lamps in Forest Park.

RUMFORD FALLS, ME.—Mr. F. A. Danforth is preparing to erect a large grist mill which is to be run by an electric motor of 15 to 20 horse power.

CARDINGTON, O.—Plans and specifications have been prepared, and bids will be received on a complete electric light plant. Geo. W. Bowyer is city clerk.

STEELTON, PA.—The Electric Light Company was granted a charter. The capital stock is $10,000. The directors are M. G. Keller, D. Z. Witmer, J. C. Redsecker.

SPRINGFIELD, MASS.—A vote will be taken at the next city election on the matter of municipal lighting, as the city is receiving poor service from the electric light company.

BOWLING GREEN, O.—E. H. McKnight, president of the Bowling Green Electric Light Company, purchased three lots upon which his company will at once erect an electric light plant.

ROME, GA.—It is contemplated to develop the water power of the Etowah River and erect a plant for supplying electricity to the city. Z. B. Hargrove, J. W. Rounsaville and T. F. Howell are interested.

ROME, GA.—A company is being organized by Z. B. Hargrove, J. W. Rounsaville and T. F. Howell to develop the water power of the Etowah River and to erect a plant for supplying electricity to the city.

BRADFORD, PA.—The Bradford Electric Light and Power Company has been awarded the contract for the erection of a new electric light and power station, which will be one of the most complete in Western Pennnsylvania.

EAST DUBUQUE, ILL.—Sealed proposals will be received until August 1 for the erection and completion of an electric light, water and fire house at East Dubuque, Ill. Proposals are to be addressed to the city clerk.

SYRACUSE, N. Y.—Edward Kanaley will erect an electric light plant at Edwards Falls, on Limestone Creek, near Manlius, to supply light and power to the villages of East Syracuse, Eastwood Heights, Fayetteville and Manlius.

BLOOMINGTON, ILL.—The special committee made its report advising the reconstruction of the electric light circuits, the purchase of a new dynamo, that 71 new lamps may be put in circuit. After the debate the report was adopted.

PERRY, IA.—A boiler in the water works station and electric light plant in this city exploded, totally wrecking the building and destroying the machinery The water works were owned by the city, and the electric light plant by a private company.

HARTWELL, O.—A stock company, with a capital of $20,000, is to be formed in Hartwell for the purpose of supplying electricity for street and commercial lighting. R. S. Waddell, who is mayor of the village, is at the head of the enterprise. Proposals are now being received.

CAMBRIDGE, O.—The report of the special committee on electric light was read, received and the committee discharged. The committee recommended the city to erect a plant to consist of two arc dynamos of 60-lamp capacity, and an incandescent dynamo of 1,000-lamp capacity.

BUFFALO, N. Y.—M. E. Beebe & Sons have prepared plans for a seven-story fire-proof building to be erected on Main and Washington streets, by Mooney & Brisbane. The building will be heated by steam and will be provided with an electric light plant. The architects will have general supervision of the work.

MIDDLETOWN, N. Y.—Sealed proposals will be received until August 8 for supplying for one or three years, from September 1, 100 arc lights, of 2,000 candle power each, or their equivalent in gas lamps or naphtha lamps; also price for each additional light. Lights to burn from dark until dawn, each and every night. Ira Dorrance is president and E. M. Hamilton city clerk.

TRENTON, ONT.—Tenders will be received until August 15 for the erection and furnishing of an electric light plant, including poles and wires, lamps, etc., and for erecting a power house on the water power owned by the town of Trenton, to be owned and operated by the municipality. Also a tender for lighting the town of Trenton, the tender to state price separately and to furnish his own plans and specifications. Geo. Crowe is chairman.

THE ELECTRIC RAILWAY.

POQUONOCK, CONN.—An electric road will be built here.

RINGTOWN, PA.—An electric railway between Ringtown and Shenandoah is being talked over.

CORTLAND, N. Y.—The directors of the electric road are talking seriously of extending their road to Little York.

UNION MILLS, MD.—Efforts are being made to organize a company to construct an electric railway through Leicester Town.

CHICAGO, ILL.—The Central Rapid Transit Company, capital stock $1,500,000, contemplates extending its lines to Dunning and Norwood Park.

TRENTON, ONT.—Bids will be received until August 15 for the erection of an electric power house. Geo. Crowe is chairman of the committee.

BALTIMORE, MD.—The Baltimore, Middle River & Sparrows' Point Electric Railway survey has been completed. T. B. B. Gatch is president of the company.

MILL HALL, PA.—The people of the Mill Hall want the Electric Street Railway Company to light their town by electricity. The matter will receive consideration.

WASHINGTON, D. C.—The Metropolitan Street Railway Company bill was passed by the Senate, authorizing the company to adopt an underground electric system.

BALTIMORE, MD.—The City & Suburban Railway Company is preparing to secure a right of way for an extension of its electric road to London Park and Catonsville.

ANNAPOLIS, MD.—Local and Philadelphia parties are interested in a project to construct and operate an electric railroad from Annapolis to Bay Ridge and Arundel-on-the-Bay.

PAMAQUA, PA.—Work has been commenced on the Inter-County Electric Railroad. The road will run from Lansford and Summit Hill, and will connect with the Switchback.

LEIPERVILLE, PA.—It is rumored that a trolley line is to be built on the Swarthmore road, between Leiperville and Swarthmore, to connect the two main lines of the trolley system.

HAMMOND, IND.—Messrs. Talford, Burnham and Rand, McNally & Co. are projectors of a new street car line between this city and Chicago. Work will commence early next month.

LOCK HAVEN, PA.—Proposals are wanted for the erection of the power house and car barn of the Lock Haven Electric Street Railway. Plans and specifications may be had of R. H. Irvin.

LOWELL, MASS.—Work on the extension of the L., L. & H. Electric Road, from Glen Forest to Lowell, will be begun in about two weeks. When the line is completed the Lowell, Lawrence & Haverhill road will have a 60 mile track in operation.

NYACK, N.Y.—A meeting will soon be called for the purpose of forming a stock company with the view of building an electric railroad from Nyack to West Nyack, and eventually to Suffern.

NEW ROCHELLE, N. Y.—Work on the trolley road, that has been planned to run from Drakes avenue, through Huguenot street, will be commenced soon. It is expected to have the line in operation by October 1.

CHAMBERSBURG, PA.—It is said some capitalists are considering the feasibility of the construction of an electric railroad from Chambersburg to Scotland and thence to Green Village and back to Chambersburg.

WILMINGTON, DEL.—The Wilmington City Railway Company began preparations on Washington street, between Delaware avenue, for the single line of electric railway on the five squares between these two points.

LOCK HAVEN, PA.—The site for the power house for the new railway company has been decided upon, and the erection of the building will begin in a few days, to be finished by the time the railway is completed.

MEMPHIS, TENN.—The Raleigh Springs Railroad Company is reported purchased by A. M. Billings, of Chicago, and others. The road is 12 miles long and will be operated by the Citizens' Street Railroad Company.

CONWAY, MASS.—Conway citizens have already subscribed $25,000 for the new electric street railway to be built from the village to the railroad station. It is estimated that the road and all equipments will cost $50,000.

DANBURY, CONN.—The selectmen have at last voted to give the Danbury & Bethel Horse Railway Company permission to construct a trolley line on the town roads, in accordance with plans and specifications filed by the company.

SAN FRANCISCO, CAL.—The citizens of the Richmond district are enthusiastic in their endorsement of Adolph Sutro's proposed street railway through that section to the Cliff House. A meeting of the property owners and residents is to be held in a few days to take some action in aiding the project. Richmond citizens have been asked to subscribe for some of the stock of the new company and have signified their intention of doing so. Already $20,000 worth of stock has been placed.

CHICAGO, ILL.—The plans of the northwestern extension of the Lake street "L" road have been finally approved by the city authorities, and it is expected that work will soon commence on the new division of the road. The extension branches off the main line at Western and Stresian avenues, and covers a great stretch of territory.

POTTSVILLE, PA.—Sealed proposals will be received by the Schuylkill Electric Railway Company until August 9 for excavating the foundation for a car barn and machine shop. Also proposals for the completion of car barn and office from the foundation up, in accordance with plans and specifications made by Chas. P. Krieg, architect.

READING, PA.—Mr. Johnson introduced an ordinance granting the Reading & Southwestern Street Railway Company the privilege to extend its tracks on Franklin street eastward, and thence on certain streets, with the right to construct the necessary curves and turnouts, and to string overhead wires to operate the said extension or additional line of electric power.

PERSONAL NOTES.

DR. ALLAN J. HORNSBY will soon publish a book entitled "Electricity at the World's Fair," which will describe the various electrical features of the Chicago Exposition.

A CORRECTION.—In the personal mention of Mr. George Kirkegaard in our last issue we inadvertently stated that he was the inventor of the lamp being manufactured by The Solar Arc Lamp Co., of Brooklyn, and also organizer of the company. We desire to correct that statement, as it did injustice to Mr. Peter Kirkegaard, brother of the subject of our sketch, to whom these honors belong.

MISCELLANEOUS NOTES.

CABLE LITIGATION.—The English Court of Appeals on July 10 rendered a verdict in favor of the Anglo-American Telegraph Company and against the Compagnie Francaise du Télégraphe de Paris à New York, claiming damages for loss sustained in consequence of the rupture in 1887 of a pooling arrangement made six years previously. The court held that the Pouyer-Quertier Company should have sought the approval of the French Government before breaking the agreement, failing which it acted on its own responsibility and at its own risk. But as it was evident by the Ministerial despatch of May 21, 1891, that the French Government would not have given its consent to the fusion of the two companies, the Anglo Company were only entitled to damages for any injury it might have sustained through the rupture for the period between December 31, 1886, and May 21, 1891. The court was not able itself to assess these damages, and therefore referred the matter to MM. Flory and Verbeecque and a third person yet to be chosen, to determine the amount to be paid as compensation to the Anglo Company. The Pouyer-Quertier Company are to pay all costs up to and including this judgment, the question of further costs being reserved.

Trade and Industrial Notes

THE GENERAL ELECTRIC LAUNCH COMPANY, 44 Broad street, and Morris Heights, New York, has changed its name to the World's Fair Electric Launch Company.

E. GOTHBERG, 67 Centre street, New York, owing to a mistake of the printer, was quoted in our last issue as manufacturing and selling electric light fixtures, whereas his business is making chandelier trimmings, arc lights and fan covers, metal novelties, etc.

THE NATIONAL TELEPHONE MANUFACTURING COMPANY, of Boston, has just received an order for 1,000 receiver and transmitter telephones, for use in the new Hotel Majestic, New York City. This order speaks well for the efficiency of the National telephone.

THE SIEMENS-HALSKE ELECTRIC COMPANY'S factory, Chicago, was burned last week, the loss being $50,000. All patterns and drawings were saved and we are informed that manufacturing was immediately resumed, and that deliveries will only be delayed 90 days.

H. H. MILLS, of Syracuse, N. Y., representing the Crouse Carbon Company, has recently been awarded contracts for furnishing the Syracuse Electric Light Company and the Utica Electric Light Company with carbons, both of which were awarded after strong competition.

THE CUTTER ELECTRICAL AND MANUFACTURING COMPANY, 27 South Eleventh street, Philadelphia, informs us that its commutation switch, which has been advertised for the last two years, is exactly the same as that described in an article by Mr. Marchland in our issue of July 14, 1894.

W. R. BRIXEY has been exceedingly fortunate in carrying off World's Fair awards, having secured the only awards for telegraph and telephone cables, underground, aerial and submarine, and has just been informed that the highest award for insulated electric light wires has been allotted to him.

A. O. SCHOONMAKER, 158 William street, makes a specialty of India mica, claiming it to be the best in the market for all insulating work; but in order to meet the demand he is now offering to the trade a superior quality of Canada amber mica, cut, uncut and stamped for segments at lowest prices.

SAMUEL W. RUSHMORE, 126 Liberty street, New York, informs us that the six search lights for the Southern Pacific Steamship Company, to which we referred in these columns in our issue of July 28, were the well-known Huntington search lights that are also being made for the Scott Electrical Manufacturing Company.

THE JAMES LEFFEL & CO., of Springfield, O., has issued a fine and complete new pamphlet, illustrating and describing their well-known line of upright and horizontal steam engines and steel boilers, with latest improvements, which were awarded diploma and medal at the World's Fair. It should prove of value to all interested in this line.

W. C. STERLING & SON, one of the oldest cedar firms in this country, are prepared for a large business this year. They have received three large crib rafts of cedar poles at their pole yards at Monroe; one from Canada and two from Northern Michigan, including 30,000 poles, and expect to receive two more rafts during the summer. About 20 cars per week are also being shipped in and all are sorted, so as to be able to make prompt shipments. Their yard at Monroe is the largest in the world, and, besides this one, they have two more in Northern Michigan. Within the last month they have shipped 20 car loads to Texas, and are receiving orders that keep them very busy.

THE MATHER ELECTRIC COMPANY, of Manchester, Conn., reports signs of marked improvement in the electrical business, having on hand more work than at any other time for the last eighteen months. The recent sales of its standard belted and also of its new direct connected apparatus for lighting work have been very large, necessitating a large addition to their working force in their works at Manchester. The company also reports a very good business throughout the Western and Central States, in which territory it is well represented by its well-known Western contractor, J. Holt Gates, of 1,140 Monadnock Building, Chicago.

THE ELECTRIC APPLIANCE COMPANY, Chicago, reports the demand for its celebrated Paranite High Grade Wire to be steadily on the increase. Paranite is becoming particularly popular with the trade in general all over the West. Aside from the merits of the insulation this is due possibly to the fact that it is the only high grade rubber covered wire manufactured in the West, which leads to its support partly through local pride and also from the fact that all kinds of special orders can be furnished promptly, thus doing away with the delay in transit incurred where special orders have to be made up at Eastern factories.

THE HAZLETON BOILER CO., 716 East Thirteenth street, New York, has issued a neat pamphlet containing tabulated results of 24 tests of the Hazleton boiler, which were conducted according to the methods of expert mechanical engineers. One of these tests—of a boiler at the collieries of the Messrs. A. Pardee & Co., Hazleton, Pa., which developed 228.49 h. p.—showed an evaporation of 13.22 pounds of combustible from and at 212 degrees; six tests gave an evaporation of over 12 pounds of water, reduced to combustible and boiling point, 12 tests of between 11 and 12 points, and five tests between 10.64 and 11 pounds, the former being the lowest of all of the trials.

THE UNITED ELECTRIC CORPORATION, Minneapolis, Minn., has been incorporated for the purpose of manufacturing and dealing in all kinds of electrical machinery and appliances, but for the present will confine its operations to telephones and telephone supplies. The company is well organized and starts out under most favorable auspices, having the necessary sinews of war, capital and talent. Mr. Grant, the president of the company, is a prominent capitalist in the Northwest, while Paul Bossart is a favorably and widely known electrician and pioneer in the telephone business, while both Mr. John A. Finney and Mr. George R. Kibbe are well known in the electrical profession. To Mr. Finney a great measure of the success of the recent Northwestern Electrical Association is due.

WADDELL-ENTZ APPARATUS.—Clients and friends of the well-known Waddell-Entz apparatus will be glad to learn that arrangements have been perfected by which the manufacture of the Waddell-Entz dynamos and motors will be carried on with improved manufacturing facilities and on a more extensive scale than formerly. The machines will be built in Bridgeport, Conn., in a new shop fully equipped with the most improved tools and machinery, overhead traveling crane, etc., and the most ample facilities for turning out the highest class of mechanical work with promptness and despatch. Mr. Waddell still retains his connection with the enterprise, and the sales department will be in charge of Mr. J. A. Machado, who has been connected with the Waddell-Entz Company since its organization. Correspondence and inquiries should be addressed to J. A. Machado, Agent, 203 Broadway, Mail and Express Building New York City.

THE SIEMENS & HALSKE ELECTRIC COMPANY of America, who for the last two years have been the most prominent advocates of large direct coupled units both for lighting and power service, are to be congratulated on their success in this line. The following list of railway plants erected or under construction speaks for itself: Garden City Construction Co., Chicago, four 620-h. p. generators, total 2,480 h. p.; West Chicago Street Railway Co., Chicago, three 2,000-h. p. and one 1,000-h. p. generators, total 7,000 h. p.; Johnson & Edwards, contractors for Nassau Electric Railway Co., Brooklyn, N. Y., three 667-h.p. generators, total 2,000 h. p.; Toronto Street Railway Co., Toronto, two 1,400-h. p. generators, total 2,800 h. p., City Railway Co., Dayton, O., three 400-h. p. gen-

erators, total 1,200 h. p.; Ringing Rocks Street Railway Co., Pottstown, Pa, two 135-h. p. generators, total 220 h. p.; Cincinnati Street Railway Co., Cincinnati, O., one 650-h. p. generator, total 650 h.p.; grand total, 16,400 h. p. The above table gives the rated capacity of these generators only, while those that have been in actual service have shown their capacity to stand an overload of 50 per cent. for hours, without harm or flashing on the brushes.

THE RIES SPECIALTY COMPANY, of Baltimore, Md., has made application for the appointment of a receiver to take charge of and close up the business of that company. Mr. Elias E. Ries, the president of the company, stated that the corporation is unable to successfully prosecute its business, owing chiefly to internal dissensions among some of its stockholders, and that the assets of the company are in danger of being wasted to the prejudice of the creditors. Hence the petition for a receiver, who has been appointed with the consent of all parties for the purpose of dissolving the corporation and making an equitable distribution of the assets among the creditors and shareholders. The company was incorporated June 16, 1890, and has been engaged in the manufacture and sale of several well-known specialties, including the Ries regulating sockets for incandescent lamps. The company owns a number of valuable patents, and a well-equipped manufacturing plant, occupying the entire building at No. 7 South Gay street. It is the intention of Mr. Ries to reorganize the company under more advantageous surroundings and to take up, in addition to the inventions now controlled by it, the manufacture of some additional specialties for which there is a large demand.

COMPLETE PORTABLE TESTING SETS.—Queen & Co., Incorporated, of Philadelphia, have for some years past manufactured a portable testing set comprising Wheatstone bridge, rheostat and galvanometer, and in 1891 filled a long-felt want by substituting a D'Arsonval galvanometer for the type with fibre suspension which had been used prior to that time. By means of the new form, measurements could be made close to dynamos and on shipboard or other places, subject to vibration, and where earlier apparatus could not be used at all. Last year, recognizing the desirability of extreme compactness, Queen & Co. re-designed their series of testing sets and produced the "Acme" form. It is the smallest and most complete instrument of its class made anywhere in the world, and contains a Wheatstone bridge with reversible arms, rheostat, D'Arsonval galvanometer, double contact key and also a silver-chloride battery. The latter is sufficient for all resistances up to 200,000 ohms, so that for work below this limit the instrument is self contained. The coils are wound with platinoid wire, calibrated to a guaranteed accuracy within 1-5 of 1 per cent. and the galvanometer of the highly favored D'Arsonval form. This set has been approved by the U. S. Government for marine service, and received the highest World's Fair award. During the past two weeks the orders for testing sets received by Queen & Co. have materially increased, so that this may indicate something of a revival in general business.

HARRISBURG IDEAL ENGINES.—W. R. Fleming & Co., representatives of the Harrisburg Foundry and Machine Works in New York and New England, have handed us a list of engines for electric purposes for which they have taken contracts since May 1. Considering the dullness and general depression in business and the undoubted decrease in the bulk of general trade, the record is a most excellent one: One 200-h. p. Ideal tandem compound engine, direct connected to a Siemens-Halske generator, for the Broadway cable road; two 40-h. p. simple engines for friction driving Thomson-Houston dynamos for the new 250,000,000-c. p. lamp for the Fire Island light house; one 60-h. p. Ideal for the Stevens Apartment House, New York; two 100-h. p. deal direct connected to 50-k. w. General Electric dynamos, for the new hotel corner Seventy-second street and the Boulevard, New York; one 60-h.p standard Ideal for the American Tobacco Company, New York; four Ideal aggregating 500-h. p., arranged for direct connection to General Electric M. P. dynamos for the new Hotel Jefferson, Richmond, Va.; one 40-h. p. standard Ideal engine, boiler and complete steam plant, for Messrs. Kibbe & Co., Hartford, Conn.; one 60-h. p. standard Ideal engine, boiler and complete steam plant for electric sewage purification, for Danbury, Conn.; two 60 h. p. Ideal arranged for direct connection, for the new City Hall, Brockton, Mass.; one 70-h. p. standard Ideal for Bangor Steamship Co.; two 40-h. p. Standard Ideal for new steamships of Old Dominion S. S. Co.; one 70-h. p. Ideal for Lyceum Theatre, Boston; one 80-h. p. Ideal, being the third order, for the Nichols Chemical Co., New York; two 100-h. p. Ideal for the plant of the U. S. P. O. at Brooklyn; one 150-h. p. engine, boiler and complete steam plant for Havana; one 50-h. p. Ideal for Brooklyn Electric Equipment Co., Brooklyn; two 80-h. p. direct connected for the New York Electric Equipment Co.; one 50-h. p. Ideal engine, boiler and complete steam plant for A. W. Burchard; one 45-h. p. engine, boiler and complete steam plant for C. E. Corwin, New Haven, Conn.; one 150-h. p., two 100-h. p. and one 60-h. p. Ideal for General Electric Co., New York City; one 75-h. p. Ideal for C. N. Knox, Hartford, Conn.; one 50-h. p. standard Ideal for J. B. Herreshoff, New York; one 50-h. p. Ideal for Atlanta (Ga.) Water Works; two 100-h. p. standard Ideal for Morrison Southern Electric Construction Co., Baltimore, Md. The contract has also been awarded to Messrs. W. R. Flemirg & Co. for supplying the station equipment of the complete central lighting and power station plant for the Port of Spain, Island of Trinidad, West Indies. This plant consists of four 250-h. p. tandem compound Ideal engines, four Harrisburg high pressure steel tubular boilers with Weitmeyer furnaces, two 2,000 light incandescent dynamos, two 50 arc achines, and one 100 kw. railway generator.

Business Notices.

BATTERY CUT OUT CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

OPEN AND CLOSED CIRCUIT CELLS.—The Hayden carbon porous cup No. 1; the Hayden carbon porous cup No. 2 cell; a Leclanche clay porous cup cell; a standard Fuller cell; a No. 2 Fuller cell; a single cylinder carbon cell; a double cylinder carbon cell. All reliable and efficient, and at prices lower than ever. THE HAYDEN-BOOKER MANUFACTURING COMPANY, 2140 DeKalb street, St. Louis, Mo.

Illustrated Record of Electrical Patents.

UNITED STATES PATENTS ISSUED JULY 31, 1894.

(In charge of Wm. A. Rosenbaum, 177 Times Building, New York.)

11,433. ELECTRIC ARC LAMP; Joseph B. McKeown, Cleveland, O. Application filed May 22, 1894. In an electric arc lamp the combination of a tubular rod suspended in the chimney by cords attached to the top end and passing over pulleys, in top of chimney; a counterbalance weight ring attached to the opposite end of said cords; guide wheels secured in the casing; armature suspended inside of said tube and the electromagnet outside of the tube and connected in the electric circuit, and adapted to operate substantially as described.

523,653. INSULATING BLOCK; H. P. Ball, Bridgeport, Conn. Application filed May 21, 1894. An insulating trolley guard wire block formed in sections having on each of their meeting faces a longitudinal groove for the guard wire and semi-circular opposing projections and recesses with extensions parallel with the guard wire groove on their meeting faces and on opposite sides of the guard wire grooves, the projection and its extensions on the opposite face, and span wire grooves on the exterior of the blocks transverse to the guard wire block.

523,662. ELECTRIC METER; Eugene Hartmann, Frankfort-on-the-Main, Germany. Application filed March 23, 1893. The combination with a wattmeter, a spring attached to an arm extending from the meter, a contact point, an electromagnet, clockwork for intermittently expanding the spring, a counter mechanism containing a wheel and carried by the armature of the electromagnet and roller.

523,663. COMMUTATOR FOR DYNAMO-ELECTRIC MACHINES; J. Hoffman, Schenectady, N. Y. Application filed December 21, 1893. This consists in covering the bar with insulating material molded thereto under heat and pressure so as to become firmly adherent.

523,667. DYNAMO-ELECTRIC MACHINE OR MOTOR; W. H. Knight, Lynn, Mass. Application filed January 9, 1894. In a dynamo electric machine, as a means of equalizing the potention of the armature, a differential winding adapted to demagnetize the poles to which the armature runs in greatest proximity, in accordance with the increased electromotive force developed in such armature.

523,685. ARMATURE FOR DYNAMO-ELECTRIC MACHINES; H. G. Reist, Lynn, Mass. Application filed September 15, 1893. In combination a commutator, positive and negative brushes thereon, each brush covering more than one segment, and connections affording multiple paths for the current between the positive and negative brushes, each of the paths containing a set of series-connected coils.

523,689. PROCESS OF MAKING SECONDARY BATTERY PLATES; W. L. Silvey, Dayton, O. Application filed September 22, 1892. This consists in immersing anodes and cathodes in a solution containing a combination of acetic acid and potassium, subjecting them to the action of an electric current while in this solution, whereby the anode is oxidized and deposited on the cathode in a metallic state, then removing the cathodes from the depositing bath and compacting the deposit and then washing them in water and placing them in a solution of sulphuric acid and water and charging them with an electric current, thus producing positive electrodes.

523,695. ELECTRO EXPANSION DEVICE; Elihu Thomson, Lynn, Mass. Application filed Nov. 25, 1887. The combination of a closed receptacle entirely filled with expansible liquid, and provided with a yielding wall or side, a heating coil arranged around the exterior of said receptacle and a non-conducting case or cover inclosing said receptacle and its surrounding coil. (See illustration.)

523,696. DYNAMO-ELECTRIC MACHINE; Elihu Thomson, Swampscott, Mass. Application filed March 19, 1894. In a multipolar dynamo electric machine or motor, a multiple wound armature, series windings upon the field magnet poles taking current from such multiple wound armature, and means adapted to equalize the induction action of such field magnet poles upon the armature.

523,697. ARC-RUPTURING DEVICE; G. T. Voorhees, Boston, Mass. Application filed May 8, 1893. In arc-rupturing apparatus, the combination of electrodes or terminals with an insulator supporting the electrodes or terminals and a circuit looped inclusively around the terminals and supported by the insulator.

523,701. AUTOMATIC CIRCUIT CLOSER; J. W. White, Providence, R. I. Application filed March 11, 1893. In a case, a coiled spring; its inner support within and near the middle of the case, its outer support outside of the case, and an electrode insulated from and within the case.

523,704. ELECTRIC METER; T. Duncan, Fort Wayne, Ind. Application filed March 14, 1894. The combination of the series or inducing field coils, the aluminium armature or closed revoluble secondary and an adjustible diverter for determining the speed and direction of the rotation of the armature.

523,723. RAILWAY SIGNAL; F. E. Kinsman, Plainfield, N. J. Application filed February 1, 1893. In an apparatus for controlling the movement of railway trains, the combination of a section of rails, an electromagnet included in the circuit between the rails at one end of the section, a train controlling circuit between the opposite ends of the rails, a battery and series of electromagnets included therein, a switch controlled by each of the magnets in series and a branched supplemental circuit, of which each branch includes one of the switches, together with a supplemental battery.

523,724. ELECTRIC SWITCH; G. E. Linton, Worcester, Mass. Application filed March 22, 1894. In an electric switch, the combination of a switch-board, binding posts having tapering walls ending in a groove, U-shaped springs provided with apertures in their middle portions, threaded screw holes in the bottom of the recesses between the walls of the binding posts, tapering headed screws to secure and adjust the springs between the walls and a tapering milled surface lever blade pivoted at one end to the switchboard, and having cut away portions at the other end, and blade portions to contact with the U-shaped springs on the binding posts.

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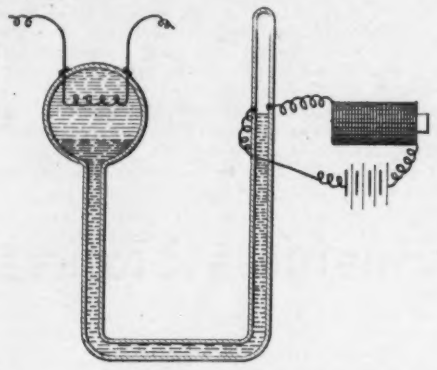
523,758. GALVANIC BATTERY; C. E. Buell, North Plainfield, N. J. Application filed December 24, 1892. A gravity battery consisting of a vessel charged with undissolved sulphate of copper and water and provided with a copper electrode and an iron electrode.

523,767. ELECTRIC SIGNAL FOR RAILWAYS; C. A. Hammond, Boston, Mass. Application filed April 12, 1894. This comprises essentially two distinct normally open track circuits extended in opposite directions from one and the same insulated track section, which each of them includes, to points within the limits of the adjoining sections; in combination with a track battery for each track circuit, a train operated mechanical circuit closer located in each of the extensions and contacts controlled by the same.

523,776. ARMATURE FOR DYNAMO-ELECTRIC MACHINES; H. E. Parshall, Lynn, Mass. Application filed January 31, 1894. An armature core comprising two or more sections or bundles of laminæ, ribs or separators between adjacent sections, and transverse channels through said sections from one side to the other thereof. (See illustration.)

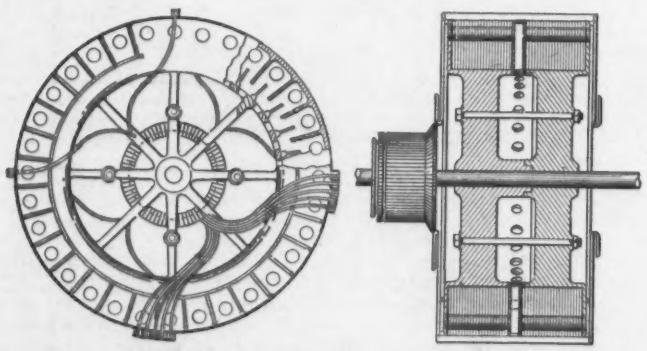
523,779. ALTERNATING CURRENT GENERATOR; E. W. Rice, Jr., Swampscott, Mass. Application filed July 25, 1893. In a generator for two-phase electric currents, the combination with a separately excited field coil, of an auxiliary field coil connected to the brushes of a current rectifier in circuit with both phases or impulses or current, whereby the field is variably excited in accordance with the work. (See illustration.)



No. 523,695.—ELECTRO EXPANSION DEVICE.

523,805. ELECTRIC CONVERTER; J. A. Cabot, Cincinnati, O. Application filed September 22, 1893. An electric converter shell, consisting of a series of soft metal plates, placed one upon another and pierced with cruciform slots, in combination with a number of readily detachable H-shaped cores, wrapped with insulated primary and secondary wires and inserted within said slots, heads applied to the ends of said shell, and fasteners that retain said heads in place.

523,822. ELECTROMAGNETIC RECIPROCATING PUMP; Charles J. Van Depoele, Lynn, Mass. Application filed December 12, 1891. The combination with a continuous current generator having stationary main positive and negative commutator brushes, of a pair of auxiliary brushes adapted to be rotated about the commutator toward and away from the stationary brushes, a reciprocating brush-shifting motor, an electromagnetic reciprocating pumping engine having a continuous current coil or coils in circuit with the stationary commutator brushes of the generator, and alternating current coils in circuit with the moving commutator brushes thereof, a switch mechanism actuated by the moving part of said pumping engine, and circuits and connections between said switch and the brush-shifting motor whereby the reciprocations of the pumping engine control the movements of the moving brushes and the reversals of current in the alternating current coils.

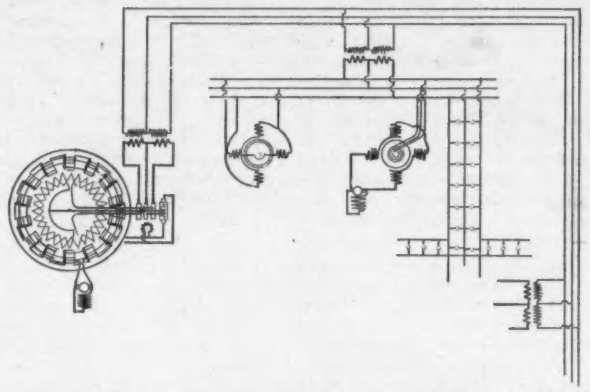


No. 523,776.—ARMATURE FOR DYNAMO ELECTRIC MACHINES.

523,847. ELECTRIC SIGNALING APPARATUS FOR RAILWAY TRAINS; W. H. Baker, Pawtucket, R. I. Application filed May 31, 1894. In an electric signaling system for railway trains, an attachment for the air brake hose couplings, the same comprising a supporting block formed to fit the side of a coupling member and having a cavity in the side toward the latter, a block of insulation filling said cavity and having one side exposed substantially in the plane of the inner face of the coupling, a binding post in said insulation and a contact plate on the exposed face of the same and in electrical connection with the said binding-post.

523,865. TESTING DEVICE FOR ELECTRIC CIRCUITS; G. A. O'Neill, Boston, Mass. Application filed October 20, 1893. A series of normally open main circuits, manually operated closures therein, a local alarm circuit, and a retarding mechanism therein normally responsive to an abnormal closure of a main circuit, combined with a manually operated actuator for and to render the retarding mechanism responsive to any closure of a main circuit, and a detent for said mechanism, whereby the alarm circuit is maintained operative after the main cirenit is reopened.

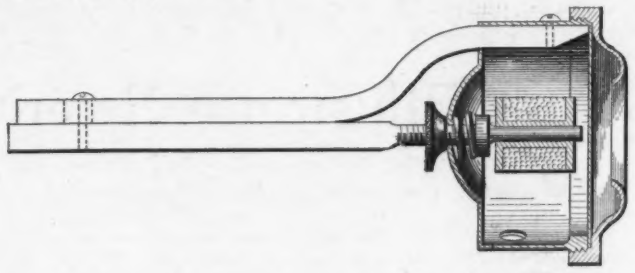
523,873. FLUID PRESSURE REGULATOR; Curtis H. Veeder and Edward D. Priest, Lynn, Mass. Application filed January 6, 1894. The combination with a fluid controller having a valve for opening and closing communication between a fluid reservoir and a fluid motive device, of an electromagnetic mechanism for operating said valve through connections permitting the fluid pressure or said mechanism to move said valve independently of each other.



No. 523,779.—ALTERNATING CURRENT GENERATOR.

523,889. AUTOMATIC LINE DISCHARGER; Jacinto Ferrer Ganduxer, Gracia, Spain. Application filed November 4, 1892. In a line discharger the combination of the magnet provided with a notched pole, the bent armature lever carrying the armature, the retractile spring, the contact screws, arranged at right angles to the axis of the magnet and the line connections.

523,892. GALVANIC ELEMENT; Albrecht Heil, Crumbach, Germany. Application filed September 27, 1893. A galvanic element consisting of the combination of parts hereinbefore specified, viz.: a silver electrode attached to a lead support sealed through the cover and embedded in a mixture of carbon and peroxide of manganese, inclosed in a linen bag, a felt cylinder or diaphragm surrounding the same, and adapted to be saturated with a suitable liquid, and a zinc electrode.



No. 523,927.—MAGNETIC TELEPHONE.

523,893. BUSHING FOR ELECTRIC ARC LAMPS; T. J. Houck, Baltimore, Md. Application filed April 29, 1894. An adjustable bushing for the carbon holders of electric arc lamps, having longitudinal slits forming spring tongues, and having upon its exterior a tapering screw thread adapted to compress said spring tongues when screwed into a socket.

523,798. MEANS FOR TESTING ELECTRIC SIGNAL BOXES; J. F. Mehren, Chicago, Ill. Application filed November 24, 1893. In an electric signaling box, the combination with a main-line circuit containing a signaling device and a relay, of a branch circuit containing a portion of the wire windings of the relay, said branch circuit being adapted to be connected into and out of shunt with the signaling device.

523,927. MAGNETIC TELEPHONE; F. H. Brown, Chicago, Ill. Application filed November 25, 1893. In an electrical telephonic apparatus, the combination with the diaphragm thereof, of a magnet arranged in juxtaposition to said diaphragm, said magnet being composed or made up of two members providing two extensions, which extensions are joined and held together and constitute one pole piece of one given polarity, and also two arms or pole pieces of the same polarity, one of which is in electrical contact with the diaphragm at or near its perimeter and the other located in such a position as that said diaphragm is adapted to vibrate within its field of force. (See illustration.)

523,946. BANK SAFE; Daniel M. Rothenberger, Lancaster, Pa. Application filed May 17, 1893. In a safe, the combination with an air chamber surrounding said safe, of an alarm, a connection between the air chamber and the alarm, whereby said alarm is sounded by forming an opening between the air chamber and the outer air, an escape-pipe leading from the air chamber, and an automatically opening spigot, held in a position to close said pipe by combustible cord passing around the safe.

523,957. ELECTRICAL WELDING OR BRAZING MECHANISM; G. D. Burton, Boston, Mass. Application filed June 3, 1893. The combination of an electric generator, an electric circuit containing it, a rheostat, an electric arc welding or brazing mechanism consisting of a conducting pencil forming the extremity of one member of the circuit and an electric conducting clamp forming the extremity of the other member of the circuit and arranged to be connected to the metal to be welded or brazed, and liquid containing cells introduced into the circuit, the positive wire of said circuit leading directly from one cell to the conducting pencil, and the negative wire of said circuit from the clam pdirectly to the other cell.